ROOM
LIBRARY
OF MICH.

OCT 1 6 1931

The Journal of HEREDITY

SHORT METACARPALS IN ONE FINGER—A DOMINANT CHARACTER

Pattern Genes in the Platyfish

Nematode-Resistance in Beans

Races Differ in Disease-Resistance

VOLUME 22 JUNE, 1931 NUMBER 6

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

DAVID FAIRCHILD, President — Vice-President, W. E. CASTLE — Secretary, C. E. LEIGHTY

Treasurer, MRS G. W. SINCELL

JOHN B. LARNER, Financial Advisor — Legal Advisors, PEELLE, OGILBY and LESH

EDITORIAL BOARD

Managing Editor: ROBERT C. COOK

M. DEMEREC — R. R. GRAVES — L. C. DUNN

H. J. MULLER — GEORGE M. DARROW — PAUL POPENOE

Members of the Council are ex-officio members of the Editorial Board

COUNCIL

W. E. CASTLE, Professor of Zoology, Harvard University, and Research Associate of the Carnegie Institution of Washington.

LEON J. COLE, Professor of Genetics, University of Wisconsin.

G. N. COLLINS, Botanist, U. S. Department of Agriculture, Washington, D. C.

O. F. COOK, Bionomist in Charge of Breeding Investigations, U. S. Department of Agriculture.

DAVID FAIRCHILD, Agricultural Explorer, U. S. Department of Agriculture.

HARRY V. HARLAN, Senior Agronomist in Charge of Barley Investigations, U. S. Department of Agriculture.

SAMUEL J. HOLMES, Professor of Zoology, University of California, Berkeley, California.

C. E. LEIGHTY, Agronomist in Charge of Eastern Wheat Investigations, U. S. Department of Agriculture.

VERNON KELLOGG, Permanent Secretary, National Research Council, Washington, D. C.

J. H. KEMPTON, Bureau of Plant Industry, U. S. Department of Agriculture.

E. W. SHEETS, Chief of Animal Husbandry Division, U. S. Department of Agriculture.

SEWALL WRIGHT, Professor of Zoology, University of Chicago.

ADVISORY COMMITTEE

W. S. ANDERSON, Genetics Department, University of Kentucky, Lexington, Kentucky.

E. B. BABCOCK, Genetics Department, University of California, Berkeley, California.

E. A. BESSEY, Professor of Botany, Michigan State College, East Lansing, Michigan.

A. F. BLAKESLEE, Plant Genetist, Carnegie Institution, Cold Spring Harbor, New York.

J. K. BREITENBECHER, McGill University, Montreal, Canada.

W. E. BRYAN, Professor of Plant Breeding, University of Arizona, Tucson, Arizona.

C. B. DAVENPORT, Director, Department of Genetics, Carnegie Institution of Washington, Cold Spring Harbor, L. I., New York.

J. A. DETLEFSEN, Professor of Genetics, Wistar Institute, Philadelphia, Pennsylvania.

RUSSELL W. DUCK, Professor of Animal Husbandry, Syracuse University, Syracuse, New York.

E. M. EAST, Professor of Plant Genetics, Bussey Inst. of Applied Biology, Boston, Mass.

R. A. EMERSON, Professor of Plant Breeding, Cornell University, Ithaca, New York.

C. P. GILLETTE, President, The Genetic Foundation, Fort Collins, Colorado.

C. M. GOETHE, Sacramento, California.

HARRISON R. HUNT, Professor of Zoology, Michigan State College, East Lansing.

H. S. JENNINGS, Professor of Zoology, Johns Hopkins University, Baltimore, Maryland.

D. F. JONES, Plant Breeder, Connecticut Agricultural Experiment Station, New Haven, Conn.

M. A. JULL, Senior Poultry Husbandman, U. S. Department of Agriculture, Washington, D. C.

F. B. LINFIELD, Director, Montana Experiment Station, Bozeman, Montana.

C. C. LITTLE, Director, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine.

JAY L. LUSH, Professor in Animal Husbandry, Iowa State College, Ames, Iowa.

H. H. NEWMAN, Professor of Zoology, University of Chicago, Chicago, Ill.

T. S. PALMER, Expert in Game Conservation, U. S. Dept. of Agriculture, Washington, D. C.

JOHN H. PARKER, Professor of Agronomy, Kansas State College, Manhatten, Kansas.

MRS. CHARLES C. RUMSEY, Wheatly Hills, Westbury, Long Island.

JOHN M. SCOTT, Vice Director, Florida Agricultural Experiment Station, Gainesville, Florida.

JOHN W. SCOTT, Professor of Zoology, University of Wyoming, Laramie, Wyoming.

A. D. SHAMEL, Pomologist, U. S. Department of Agriculture, Riverside, California.

GEORGE H. SHULL, Professor of Biology, Princeton University, Princeton, New Jersey.

W. W. SMITH, Professor of Animal Husbandry, Purdue University, Lafayette, Indiana.

CHARLES R. STOCKARD, Professor of Anatomy, Cornell University, New York City.

A. B. STOUT, Director of Laboratories, New York Botanical Gardens, New York City.

W. T. SWINGLE, Plant Physiologist in Charge of Breeding Investigations, U. S. Department of Agriculture, Washington, D. C.

LOU D. SWEET, Seedsman, Denver, Colorado.

W. H. TOMHAVE, American Aberdeen-Angus Breeders' Association, Chicago, Ill.

H. E. WALTER, Professor of Biology, Brown University, Providence, Rhode Island.

H. J. WEBBER, Director, Citrus Experiment Station, Riverside, California.

E. N. WENTWORTH, Armour's Bureau of Agr'l Research and Economics, Chicago, Illinois.

P. W. WHITING, Department of Biology, University of Pittsburgh, Pittsburgh, Pa.

The

Journal of Heredity

Vol. XXII JUNE, 1931 No. 6

IN THIS ISSUE

PATTERN GENES IN THE PLATYFISH
By Myron Gordon and Allan C. Fraser..... 169

AN INHERITABLE DEFECT OF THE HUMAN HAND
By C. P. Gillette..... 189

NEMATODE-RESISTANCE STUDIES WITH POLE SNAP BEANS
By C. L. Isbell..... 191

BOOKS RECEIVED..... 185

PLANT BREEDING ABSTRACTS..... 187

LIVESTOCK BREEDING IN RUSSIA..... 188

RACE DIFFERENCES IN DISEASE..... 198

COMING

Inheritance of Body Weight in the Domestic Fowl

Photographic inheritance charts and statistics of a "blending" character probably conditioned by multiple factors.

Origin of Hooded Barley

In the shadow of the Himalayas a queer mutation of barley awns took place a century or so ago that has recurringly interested farmers all over the world, and invariably caused them disappointment.

Siamese Twins Unlike

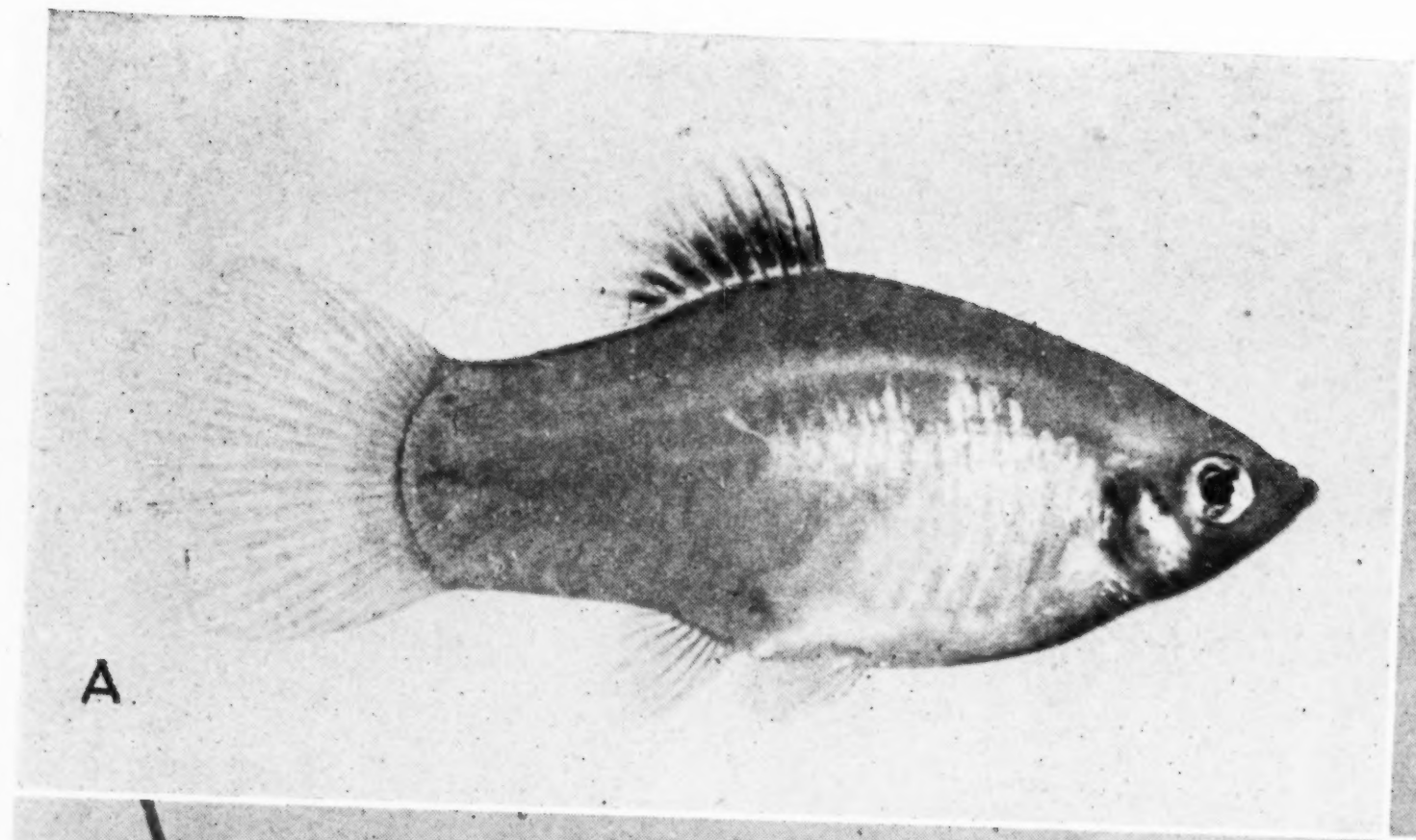
The most closely associated of identical twins the most dissimilar, and a theory of twinning to account for this fact.

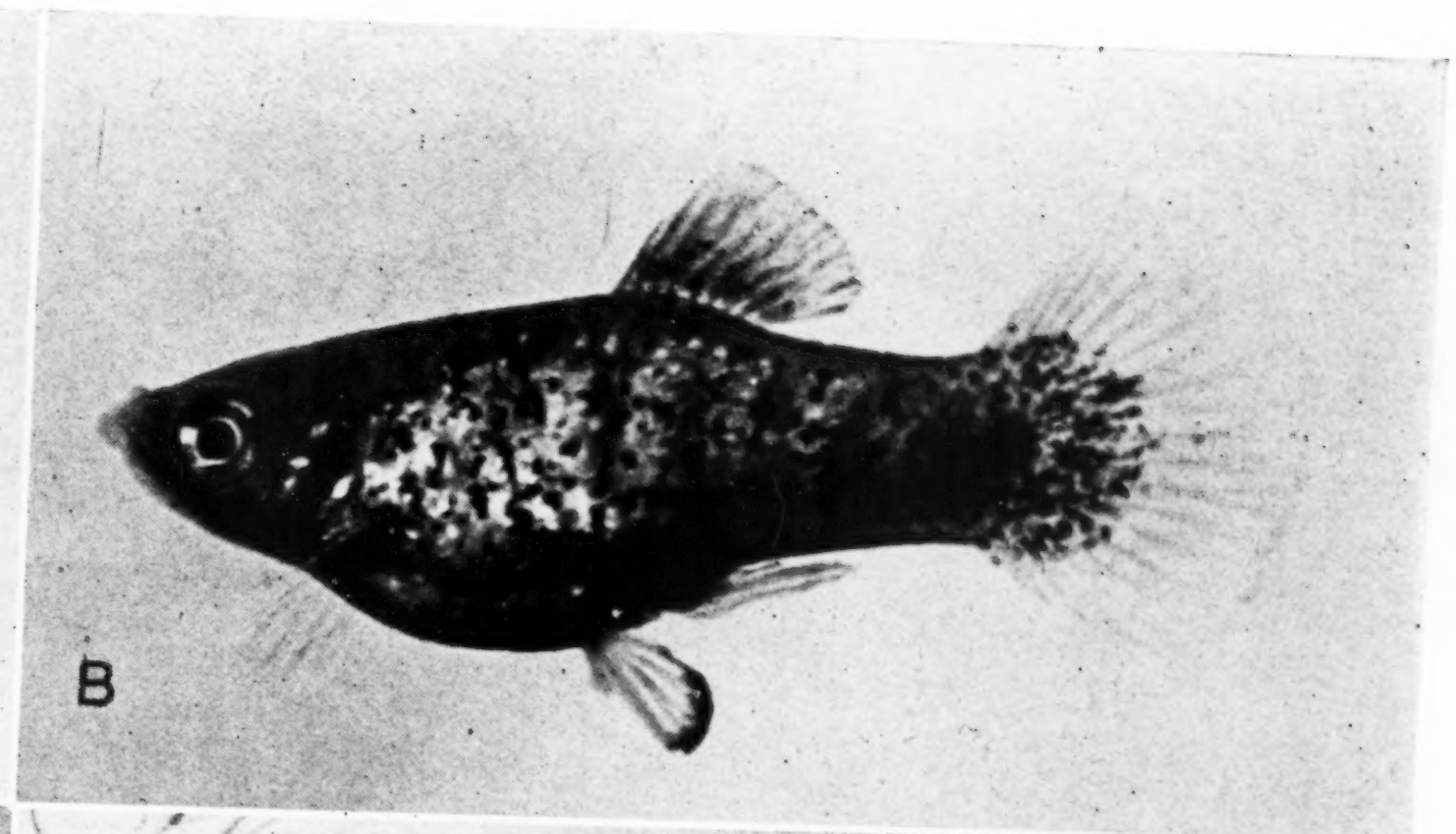
X-Ray Mutation in Cotton

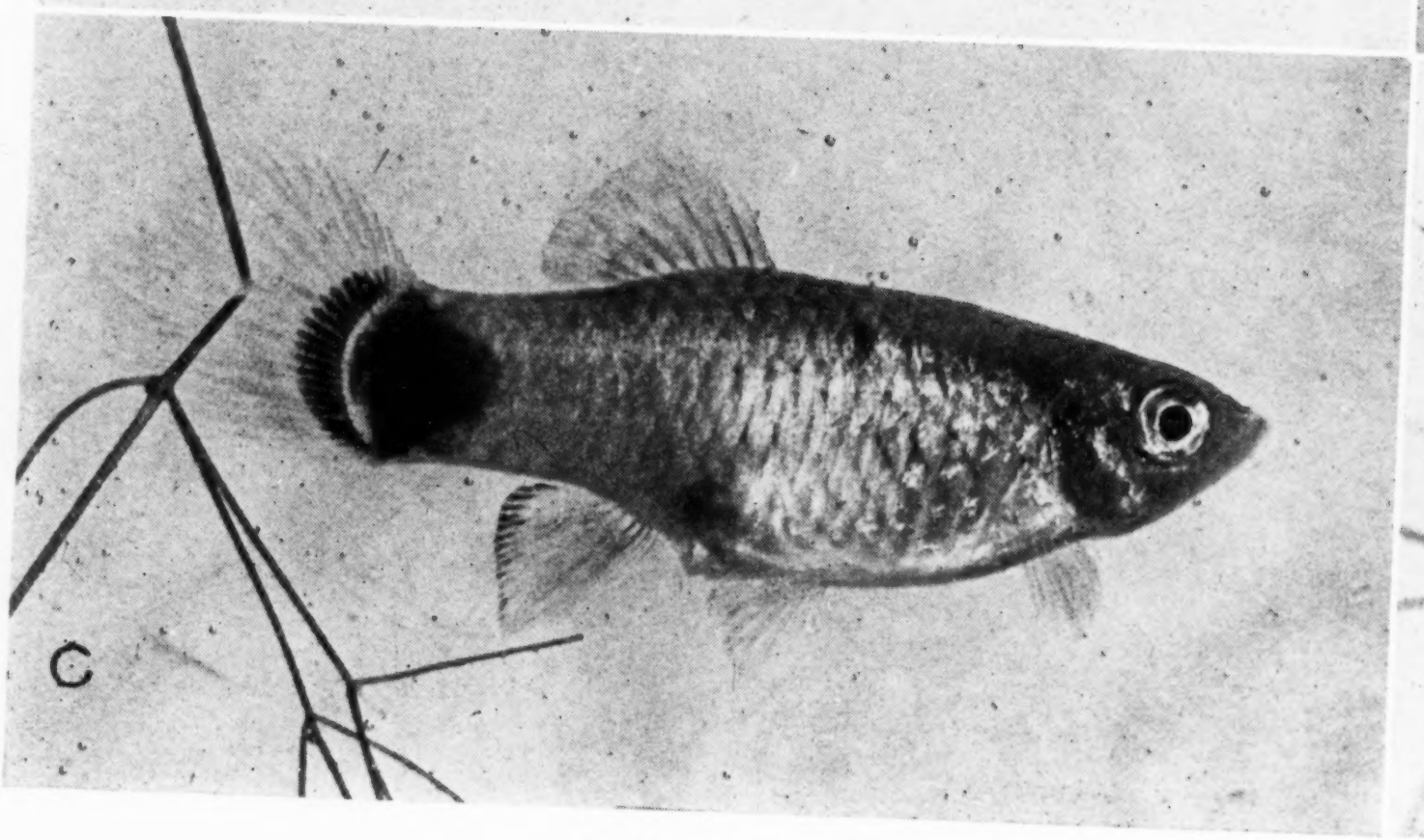
Dwarfs, color chimeras, leaf shape reversions, and other changes brought about in plants from X-rayed seed.

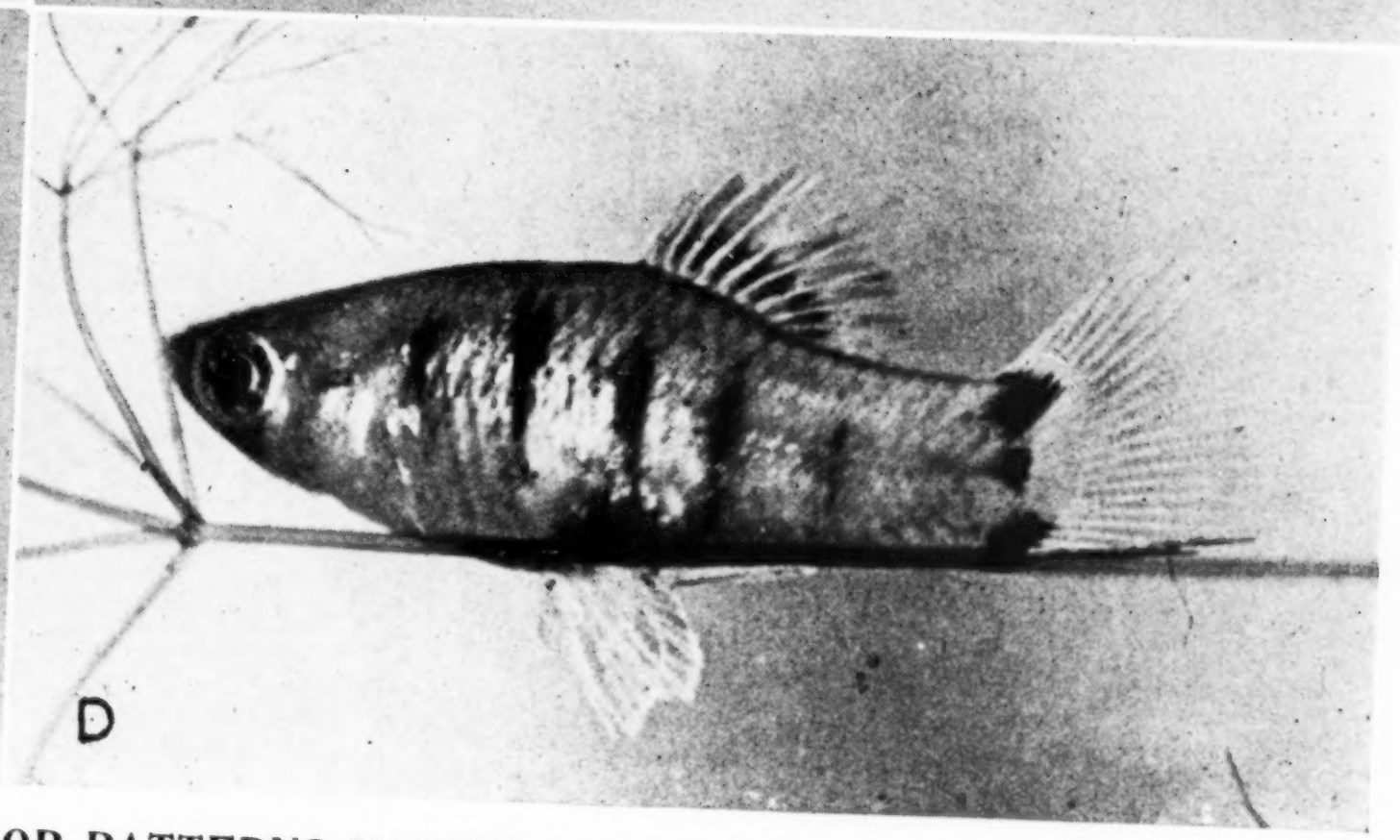
The JOURNAL OF HEREDITY is published monthly by the AMERICAN GENETIC ASSOCIATION, at 1918-32 Harford Avenue, Baltimore, Md., and Victor Building, Washington, D. C. Address all communications regarding editorial matters and the business management of the Association to Room 306, Victor Building, Washington, D. C. Entered as second-class matter February 24, 1923, at the postoffice at Baltimore, Maryland. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized December 20, 1918. Contents copyrighted 1931 by the American Genetic Association. Unauthorized reproduction of material from THE JOURNAL not permitted. The title "Journal of Heredity" is registered as a trade-mark in the U. S. Patent Office.

$3.50 a Year *Prices of back numbers on application* ***35c. the Copy***









ANALYSIS AND SYNTHESIS OF COLOR PATTERNS IN THE PLATYFISH

Frontispiece

The mating of the two platyfish shown in the upper pair will indicate the method employed for the isolation of hereditary color pattern factors. A platyfish (*B*) having several color patterns (spots, red, stipples, one-spot) is mated with a test fish, the goldplaty (*A*), a multiple recessive. By inbreding the first generation or by repeated back-crosses to the goldplaty type, the hereditary factors segregate. Four patterns have been isolated that occur in the tail region: the one-spot, twin-spot, crescent and moon.

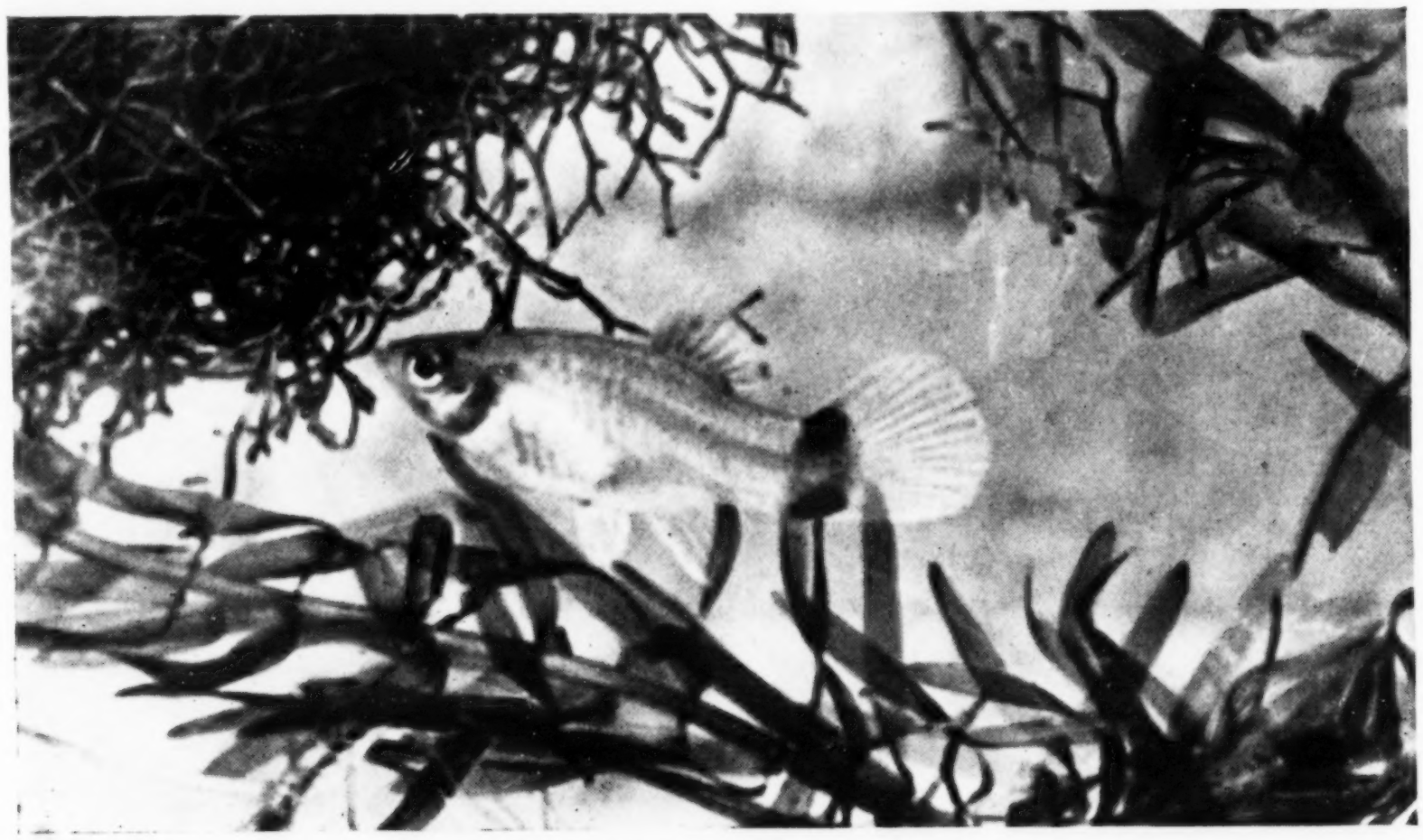
After the isolation of the four tail patterns, it is possible to recombine them in a number of ways. In the lower pair of figures the female (*C*) is a crescent, moon; the male (*D*) is a three-spot platy (one-spot plus twin-spot). For details of the results of mating a crescent, moon with a one-spot, twin-spot see table 8, cross number 20, page 182. The photographs

PATTERN GENES IN THE PLATYFISH

Inheritance of Naturally Occurring Color Pattern Variations in the Mexican Killifish, *Platypoecilus maculatus**

MYRON GORDON† and ALLAN C. FRASER‡

Zoological Laboratory and the Department of Plant Breeding, Cornell University, Ithaca, N. Y.



THE TWIN-SPOT PLATY

The present day representative of the twin-spot platy, reared in the aquarium. The twin-spot pattern is inherited as a simple Mendelian dominant. The picture is of a live female and is approximately life size.

GENETICAL studies of such variations in species as occur in nature are important because they make it possible to interpret the results of field investigations in the light of experimental data obtained in the laboratory. They reveal whether an observed variation is a fortuitous somatic change of no permanent significance or whether it is genetically fixed and transmissible to new generations.

The small viviparous killifish, *Platypoecilus maculatus*, of tropical Mexico, is remarkable for the large number of color patterns which it displays. It was imported into the United States and Europe in 1907 to serve as an ornamental aquarium fish. It has taken kindly to the artificial quarters given to it and has been successfully bred and reared in aquaria when proper conditions of water, temperature and food were available.

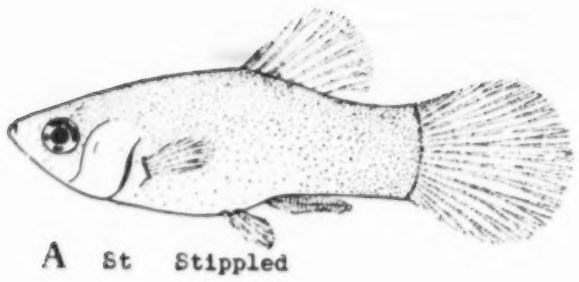
A close examination of the original descriptions of *Platypoecilus maculatus* as given by Gűnther[10] and later ex-

---

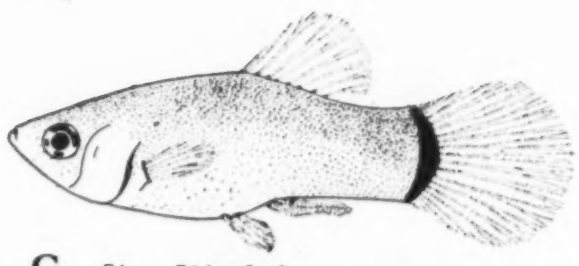
*Published as Paper No. 178, Department of Plant Breeding, Cornell University, Ithaca, New York.

†National Research Council Fellow in the Zoological Sciences.

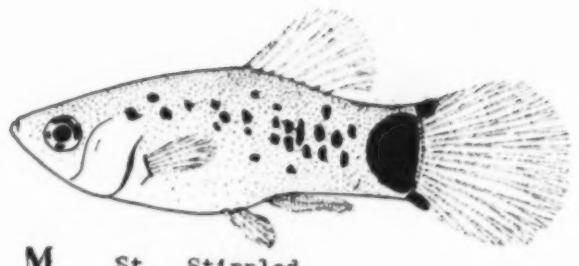
‡Assistant Professor of Plant Breeding. The investigation upon which article is based was supported in part by a grant from the Heckscher Foundation for the Advancement of Research, established by August Heckscher at Cornell University.



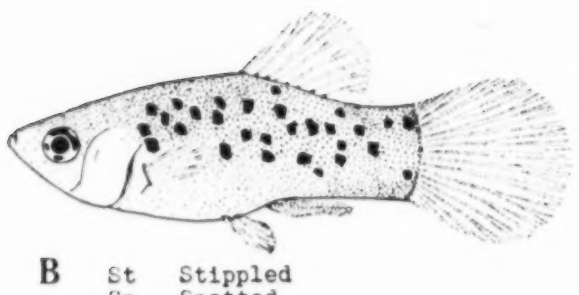
A St Stippled



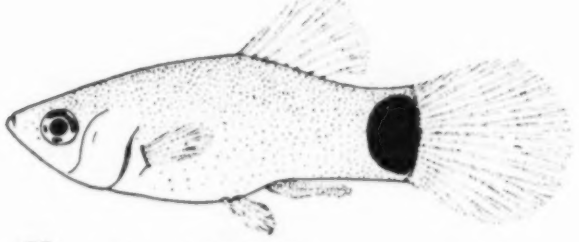
G St Stippled
Cc Crescent (crescent)



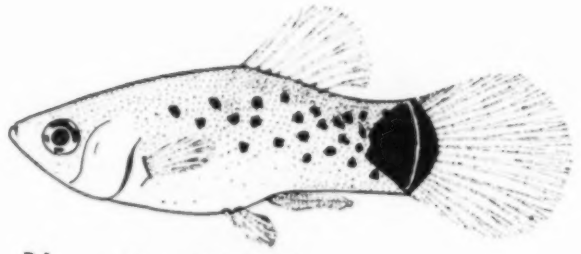
M St Stippled
Sp Spotted
O One-spot
M Moon



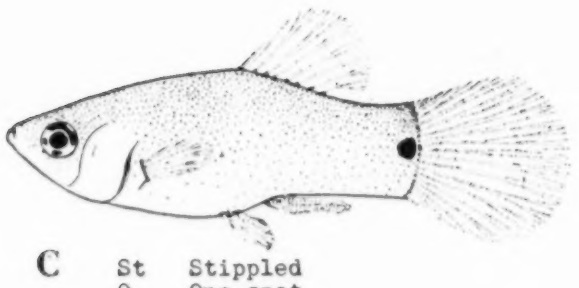
B St Stippled
Sp Spotted



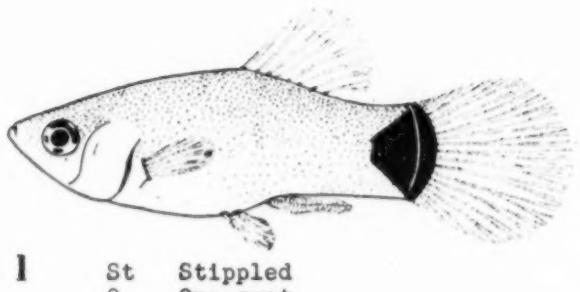
H St Stippled
Cb Crescent (battle-ax)



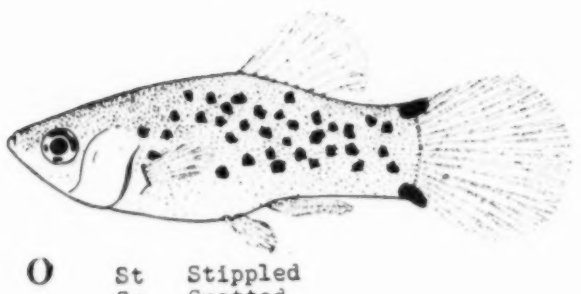
N St Stippled
Sp Spotted
O One-spot
C Crescent



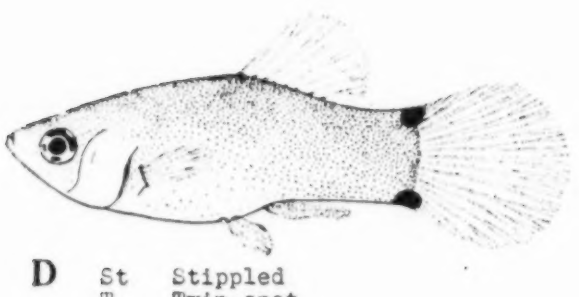
C St Stippled
O One-spot



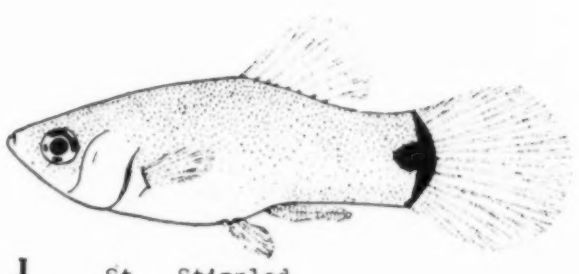
I St Stippled
O One-spot
C Crescent



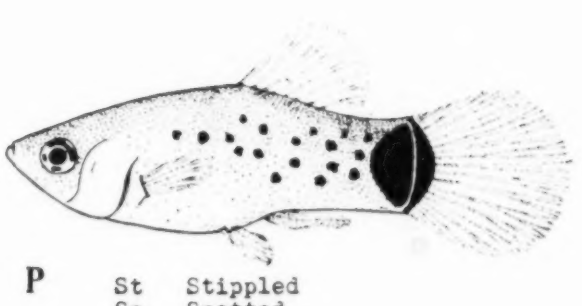
O St Stippled
Sp Spotted
T Twin



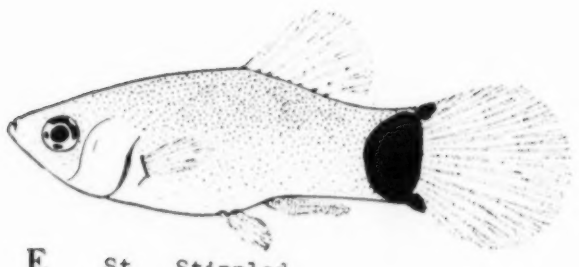
D St Stippled
T Twin-spot



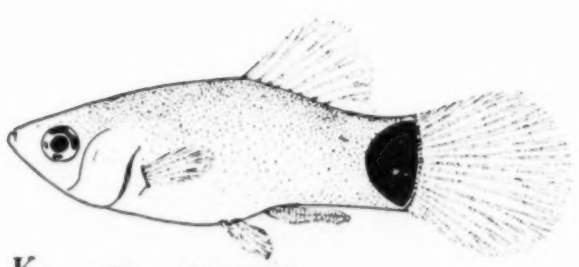
J St Stippled
O One-spot
Cc Crescent (crescent)



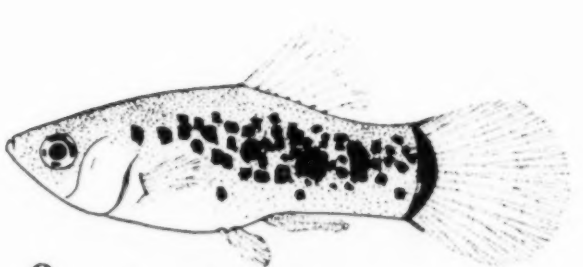
P St Stippled
Sp Spotted
C Crescent



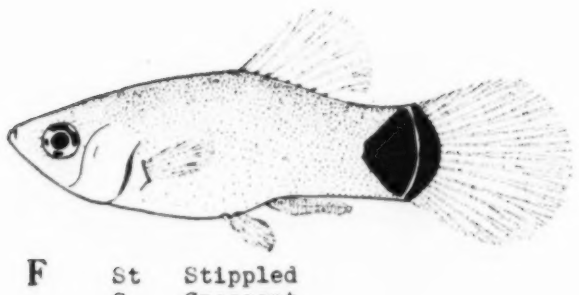
E St Stippled
M Moon



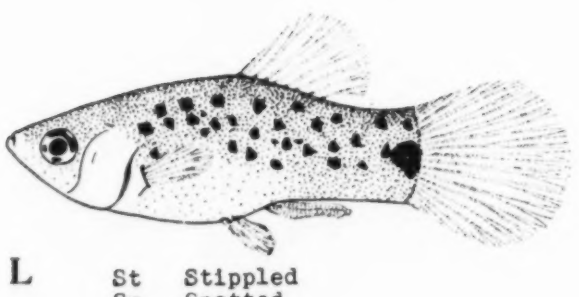
K St Stippled
O One-spot
Cb Crescent (battle-ax)



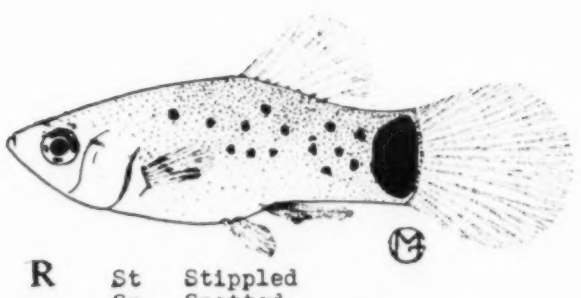
Q St Stippled
Sp Spotted (Black?)
Cc Crescent (crescent)



F St Stippled
C Crescent



L St Stippled
Sp Spotted
O One-spot



R St Stippled
Sp Spotted
Cb Crescent (battle-ax)

VARIABILITY OF COLOR PATTERNS IN NATURE

Figure 2

This diagram is based upon the actual specimens of the killifish which were collected by Meek from the Rio Papaloapam, State of Vera Cruz, Mexico, in 1904. Some of these fishes have complex color patterns. By genetical methods of segregation and recombination of isolated patterns, interpretations of the actual pattern components of the wiid fishes may be made. The pattern constitution of each type is indicated beneath each figure.

tended by Meek[12] indicates that nearly all of the color patterns now seen in aquarium reared fishes have almost exact counterparts among their progenitors living in the feral state* A further study of variation in this species has been made possible through the courtesy of the Directors of the Field and of the National Museums, by the loan of the specimens of Platypoecilus which were collected by Meek[12] from the Rio Papaloapam at Obispo in the State of Vera Cruz. Detailed evidence is now available to show that aquarium reared and naturally occurring specimens do not differ in their fundamental color patterns. This implies that the color pattern variations in Platypoecilus have not originated during the period of its domestication, but have evolved under natural conditions in their native Mexican habitat.

The purpose of this paper is to show that a number of these variations may be referred to definite genes and also to indicate how these genes are related to one another.

The Color Patterns in Meek's Specimens

The sixty-eight specimens of *Platypoccilus maculatus* (catalogue number 4667 of the Field Museum, and 55809 of the National Museum) may be classified into six groups as follows:

Group 1. Stippled
" 2. Spotted
" 3. One-spot
" 4. Twin-spot
" 5. Moon
" 6. Crescent

C^b

C^c

The stippled pattern is due to the presence of a large number of small black pigment cells or micromelanophores which are found in all parts of the fish. They give the fishes the characteristic olive gray color. The inheritance of the factor for stippling (*St*) as an autosomal dominant has been presented in a former paper[8].

The spotted pattern is due to the presence of a smaller number of large black pigment cells or macromelanophores which are scatterred irregularly over the entire body. This pattern was found[7] to be controlled by a sex-linked, dominant factor, (*Sp*).

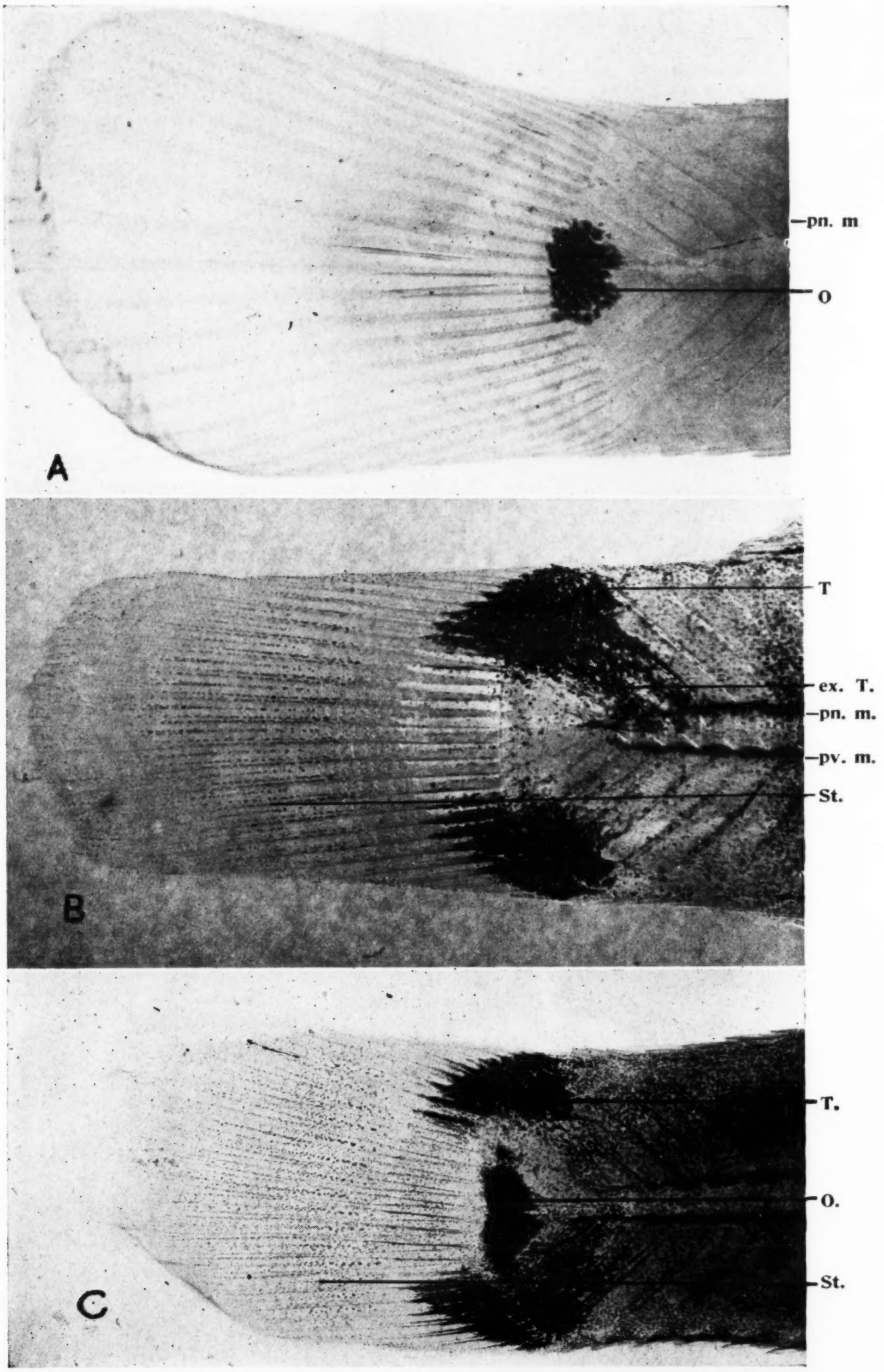
The four patterns: one-spot, twin-spot, moon and crescent are all due to the presence of micromelanophores in the area of the caudal peduncle and caudal fin. The distribution of these pigment cells with respect to variations in the type of cell grouping determines the specific pattern.

In the one-spot pattern the pigmented area is the mid region of the caudal peduncle just anterior to the attachment of the caudal fin (Figure 3*A*). The pattern is about the size of the eye of the fish and is slightly blunt in front and more rounded behind.

The twin-spot pattern consists of two elements (Figure 3*B*): an upper and a lower member which occur on the dorsal and ventral border immediately above and below the one-spot pattern. The pigmented areas are partly on the caudal fin and partly on the caudal peduncle. These two elements always occur together in the Platypoecilus observed.

The moon pattern consists of three elements (Figure 4*B*), a large roundish pigmented area on the posterior part of the caudal peduncle and two smaller pigmented areas near the dorsal and the ventral margin of the anterior part of the caudal fin. The single large spot is referred to as the *moon* proper and the two smaller pieces as the *satellites*.

*It seems highly probable that these patterns of the aquarium fish, discussed in this paper, are identical genetically with like patterns to be found in wild fishes of this species. Two reasons lead to this belief: First, there has hardly been sufficient time, in the comparatively short period of domestication, for many new mutations to occur; and secondly, it seems unlikely that so many patterns would be duplicated in different genotypes.



ONE-SPOT AND TWIN-SPOT PATTERNS

Figure 3

Enlarged photographs of the tails of platyfish, showing the one-spot pattern (*A*), the twin-spot pattern (*B*), and the combined pattern (*C*). The patterns are inherited independently and when they are "superposed" by appropriate matings (*C*) each pattern retains its individuality. For explanation of symbols see opposite page.

The crescent pattern consists of two elements (Figure 4*A*): an anterior piece on the caudal peduncle, shaped like the head of an ancient *battle ax* (C^b), and a posterior piece located in the caudal fin, *crescent* (C^c) in shape. When these two elements occur together they are referred to as the *crescent* (*C*).

The six patterns described above rarely occur singly. Sometimes two, three or four patterns may be found in a single specimen. Among the sixty-eight museum specimens studied, which may be regarded as a sample of the fish as they occur in the feral state, eighteen combinations have been observed (Figure 2). These are listed in the following table with frequencies indicated (Table I):

Table I.
The specimens of *Platypoecilus maculatus* collected in Mexico (See Figure 2).

	Males	*Females*	*Total*	
A	2	3	5	St
B	3	2	5	St Sp
C	2	5	7	St . . O
D	1	2	3	St . . . T
E	1	1	2	St . . . . M
F	2	5	7	St C
G	0	3	3	St . . . . . C^c
H	1	4	5	St . . . . . C^b
I	1	3	4	St . . O . . C
J	1	0	1	St . . O . . . C^c
K	1	0	1	St . . O . . . . C^b
L	4	4	8	St Sp O
M	0	1	1	St Sp O . M
N	2	0	2	St Sp O . . C
O	0	2	2	St Sp . T
P	4	3	7	St Sp . . . C
Q	0	2	2	St Sp . . . . C^c
R	1	2	3	St Sp . . . . . C^b
	26	42	68	

Table II.

	Classification by groups							
		Males	Females	Total		Males	Females	Total
1.	Stippled	26	42	68	Non-stippled	0	0	0
2.	Spotted	14	16	30	Non-spotted	12	26	38
3.	One-spot	11	13	24	Non-one-spot	15	29	44
4.	Twin-spot	1	4	5	Non-twin-spot	25	38	63
5.	Moon	1	2	3	Non-moon	25	40	65
6.	Crescent	9	11	20	Non-crescent	17	31	48
	C^c	1	5	6	Non-C^c	25	37	62
	C^b	3	6	9	Non-C^b	23	36	59

EXPLANATION OF FIGURE 3

A—The One-Spot Pattern

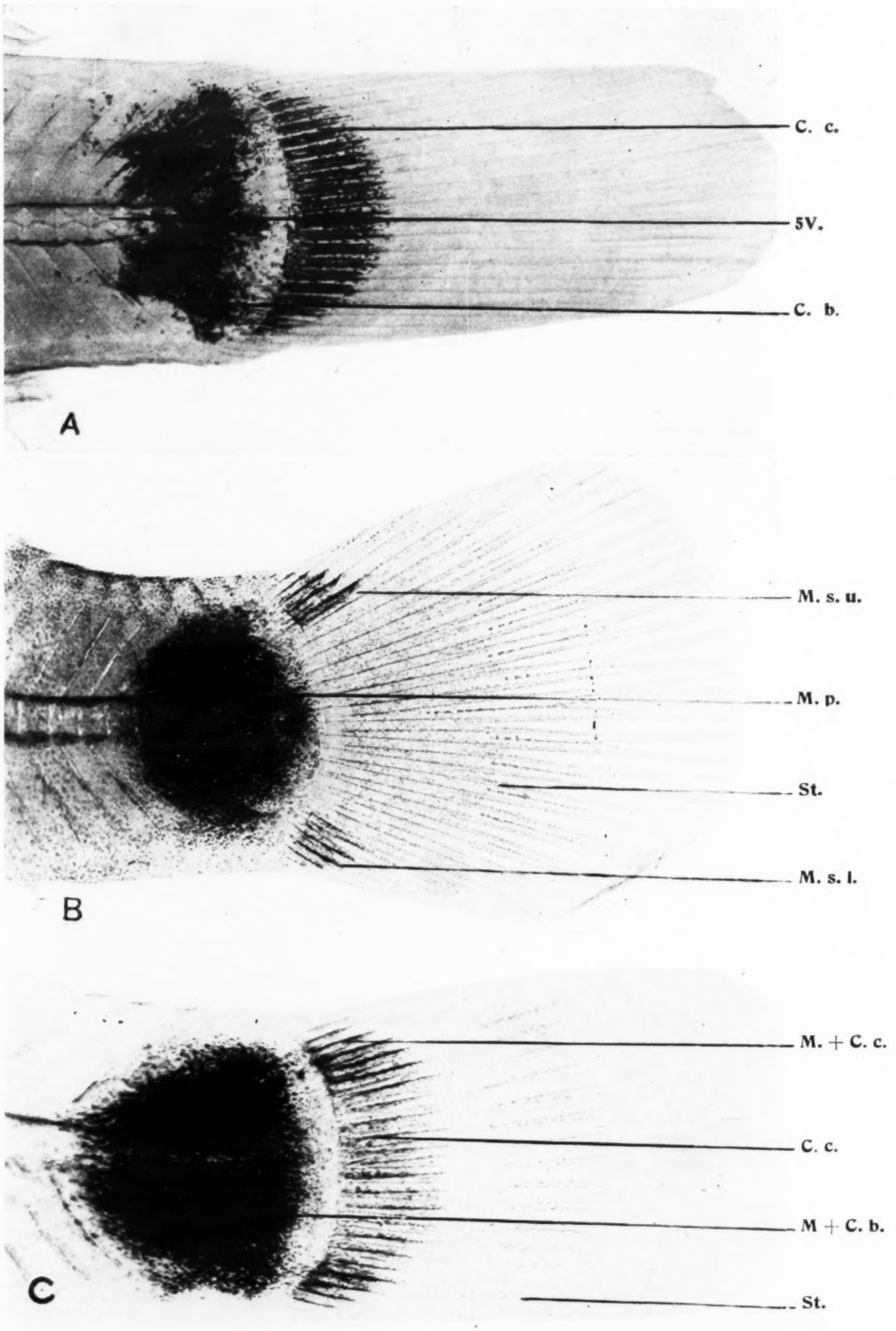
Photograph of a cleared one-spot (gold platy) 22 mm., to show extent of pigmentation of this pattern.
pn.m., Perineural melanophores in sheath about spinal cord.
O., One-spot pattern (composed of micromelanophores).

B—The Twin-Spot Pattern

Photograph of a cleared twin-spot (stippled platy) 22 mm., to show extent of pigmentation of this pattern.
T., Twin-spot pattern (composed of micromelanophores).
ex.T., Extra micromelanophores between the main masses.
pn.m., Perineural melanophores.
pv.m., Perivascular melanophores (due to stippling factor).
St., Micromelanophores of the stippling pattern.

C—The One-Spot, Twin-Spot Pattern

Photograph of a cleared twin-spot, one-spot compound derived by crossing a twin-spot (gold platy) with a one-spot (stippled platy). The identity of each pattern is clearly demonstrated in this figure.
T., Twin-spot pattern.
O., One-spot pattern.
St., Stippling pattern.



CRESCENT AND MOON PATTERNS

Figure 4

Photographs of the tails of cleared platyfish showing the elements of the crescent (*A*) and of the moon patterns (*B*), and the result of combining them (*C*). See opposite page for detailed explanation.

The most common combination is the association of the stippled or spotted patterns, or both, with one of the patterns in the caudal peduncle. Two different peduncle patterns appear together only in six cases; *and there are no cases in which more than two peduncle patterns appear simultaneously in one individual.* The reasons for these conditions will become evident after the experimental data are presented and discussed.

Experimental Data

The hereditary factor for One-spot

The one-spot platy first appeared as a distinct variety in this laboratory during the course of the work on the sex-linked factor for the spotted pattern. A spotted-platy female was mated with a stippled male. In the former it was observed that the spotted appearance was more pronounced nearer the caudal fin than elsewhere upon the body, but no significance was attached to this at that time. Out of a total number of sixty-three fishes produced from the cross mentioned above, there were twenty-nine males which were spotted like their female parent and there were thirty three females which were non-spotted like their male parent. The typical results of criss-cross inheritance of the *WZ* type for the spotted factor was seen for sixty-two fishes. (For an account of the exceptional sixty-third, a spotted female, of no consequence in the present studies, the reader may be referred to Fraser and Gordon.[7])

Of the thirty-three non-spotted females, obtained above, seventeen had a small but well defined dark area at the posterior part of the caudal peduncle. Careful reexamination of the spotted platy female parent (Figure 6*C*) revealed the fact that the unusually dark area on the caudal peduncle was not due entirely to the spotted condition alone but to some other pattern as well. Since the one spot pattern appeared in one-half of the females (the only group in this cross in which the character may be definitely distinguished), it was suspected that this new pattern was controlled by a heritable autosomal factor for which the spotted-platy female parent was a heterozygous dominant. Further experiments substantiated this hypothesis. Of the seventeen female offspring

---

EXPLANATION OF FIGURE 4

A—The Crescent Pattern

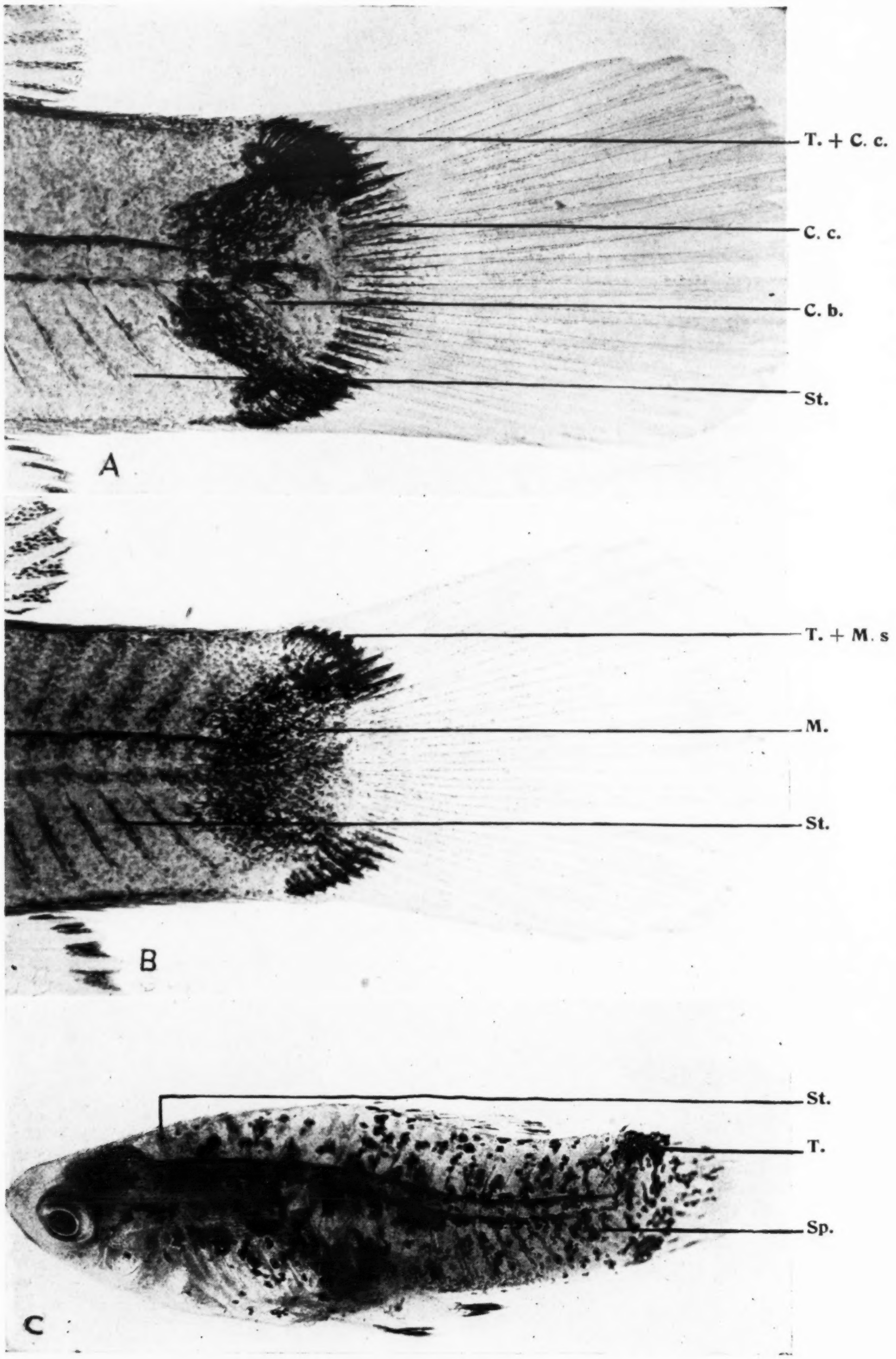
Photograph of a cleared crescent (gold platy) 22 mm., to show the two elements which make up this pattern.
C.c., The Crescent posterior part of the crescent pattern.
C.b., The battle-ax anterior part of the crescent pattern.
5v., The fifth vertebra (numbered from urostyle).

B—The Moon Pattern

Photograph of a cleared moon (stippled platy) 22 mm., to show the three elements which make up this pattern.
M.s.u., Upper satellite of the moon pattern.
M.p., The moon proper of the moon pattern.
St., The micromelanophores of the stippling pattern.
M.s.l., Lower satellite of the moon pattern.

C—The Crescent, Moon Combination

Photograph of a cleared crescent, moon compound derived by crossing a crescent (gold platy) with a moon (stippled platy). There is an obvious overlapping of the two patterns, but the presence of each pattern may be detected.
M.+C.c., The combined micromelanophores of the upper satellite of the moon pattern with those of the crescent part of the crescent pattern.
C.c., The posterior part of the crescent pattern.
M.+C.b., The anterior part of the crescent and moon pattern.
St., The micromelanophores of the stippling pattern.



TWIN-SPOT COMBINATIONS

Figure 5

Photographs of tails of twin-spot, crescent (*A*) and twin-spot, moon combinations (*B*), showing the interaction of the patterns. A rubra platy in which the twin-spot pattern was isolated is shown at *C*. For detailed explanation see opposite page.

which possessed the one-spot pattern, fourteen were also stippled (*St O*); and three were non-stippled (*st O*). Of the sixteen females of the same brood which did not show the one-spot pattern eleven were stippled (*St o*) and five were not (*st o*). This seems to indicate that there is no linkage between the autosomal factors for one-spot and stippled patterns. Other experiments which strengthen this conclusion are listed in Table III.

Further experiments were conducted to find out whether the one-spot pattern might be broken down further by crossing the fishes to the recessive, gold-platy. The results indicate that the pattern had been completely isolated. The spotted, stippled, one-spotted platy from which the one-spot pattern was finally derived has its exact counterpart in one (Number *L*, Figure 2) of the pattern combination of Meek's Mexican specimens for which there were seven representatives. (See also Figure 7 No. 5).

The Hereditary Factor for the Twin-spot

The twin-spot pattern, like the one-spot, first appeared while studies were being made of sex-linkage in Platypoecilus. Its origin was traced to a spotted-platy female (Figure 5C) in which the spotted pattern practically covered the smaller twin-spot pattern. This spotted-platy female was crossed with a stippled-platy male. The male offspring were spotted but the females were not. Half of the latter showed two distinct pigmented areas in the posterior part of the body, one above the other. The females having this isolated pattern were crossed with the gold-platy, but the pattern always appeared in its duplex condition. The conclusion was drawn that the twin pattern is controlled by a single change in the genic complex of Platypoecilus and that it may be referred to an autosomal dominant gene. (The series of crosses on this factor are listed in Table IV). A further tentative conclusion may be drawn that the factors for twin-spot and stippled are not linked.

The spotted, stippled, twin-spot combination from which the twin-spot pattern was isolated may be found represented in Meek's Mexican fishes, (Figure 2-*O*).

The Hereditary Factor for the Moon Pattern

The moon pattern was associated with the stippling pattern in the speci-

EXPLANATION OF FIGURE 5

A—The Twin-Spot, Crescent Combination

Photograph of a cleared twin-spot, crescent (stippled platy) compound derived by crossing a twin-spot (gold platy) with a crescent (stippled platy).

T.+C.c., A part of the twin-spot pattern together with part of the crescent. The upper twin bridges the space between the two elements of the crescent pattern.
C.c., The posterior part of the crescent pattern.
C.b., The anterior, battle-ax, part of the crescent pattern.
St., The micromelanophores of the stippling pattern.

B—The Twin-Spot, Moon Combination

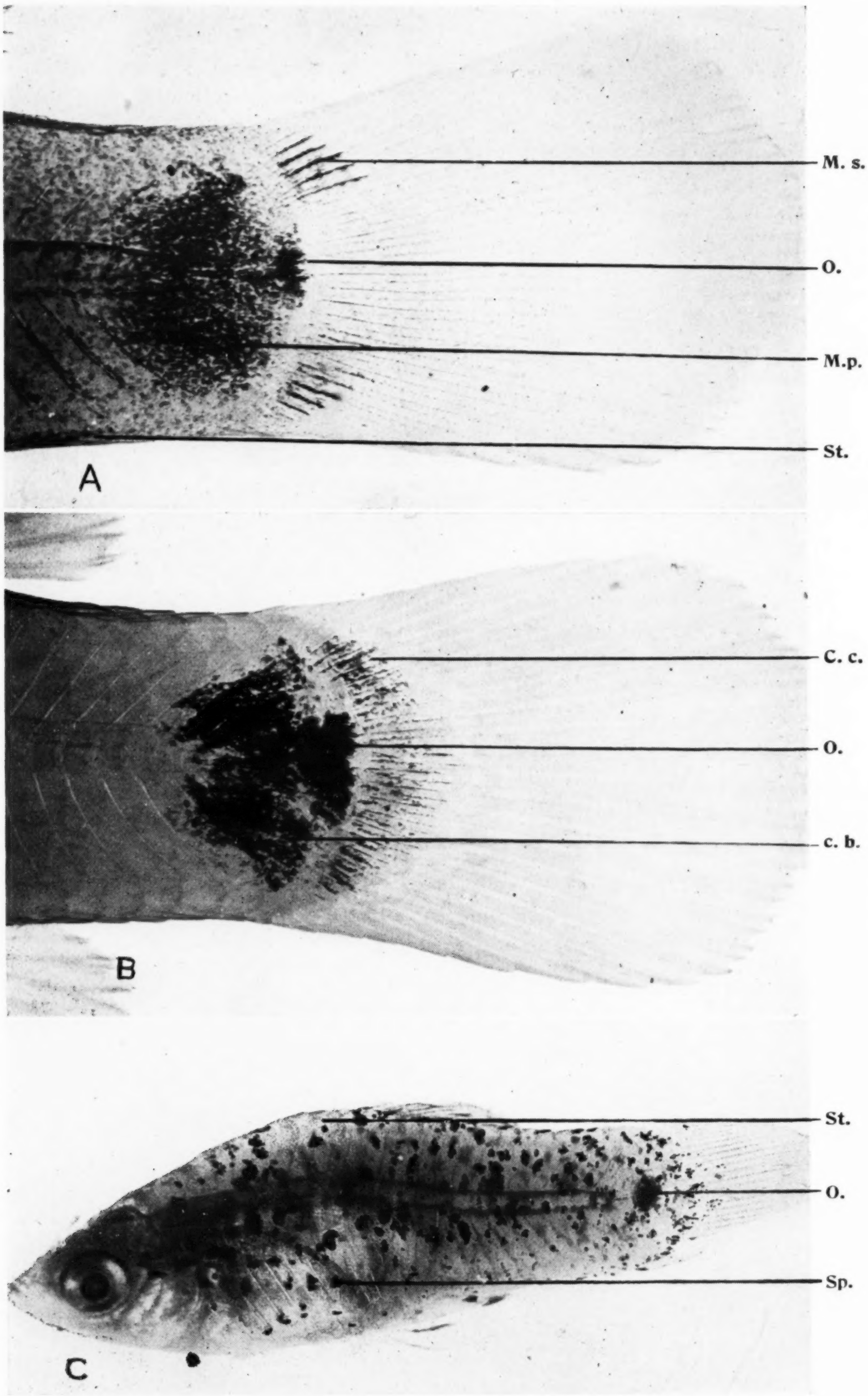
Photograph of a cleared twin-spot, moon (stippled platy) compound, derived by crossing a twin-spot (gold) with a moon (stippled platy).

T.+M.s., The upper part of twin-spot pattern bridges the space between the upper satellite of the moon pattern and its anterior associate.
M., The anterior part of the moon pattern.
St., The micromelanophores of the stippling pattern.

C—Rubra Platy With the Twin-Spot Pattern

Photograph of a cleared rubra platy from which the twin-spot pattern was finally isolated.

T., Twin-spot, upper part.
St., Micromelanophores of the stippling pattern.
Sp., Macromelanophores of the spotted pattern.



ONE-SPOT COMBINATIONS

Figure 6

The one-spot pattern combined with Moon (*A*), with crescent (*B*), and with rubra (*C*). The spots in the rubra platy (*Sp*) are due to another hereditary factor which produces large pigmented cells (*macromelanophores*), quite distinct from the micromelanophores which occur in the one-spot, moon, and crescent patterns.

mens obtained from a dealer in aquarium fishes. These fishes correspond almost exactly to one of Meek's specimens taken in Vera Cruz—it is pattern combination number *E* of Figure 2 (Figure 7, No. 12). A mating of the pair of stippled, moon platys yielded one hundred and forty-eight individuals all of which were stippled like their parents but about one quarter of them lacked the moon pattern. This was suggestive of heterozygosity of the moon factor in both parents. (See Table V). A cross was made which was designed to test the possible linkage relations of the factors for moon and stipple but rather indefinite results were obtained. (See Table V, number 12). Later crosses, in which the other factors for patterns in the caudal peduncle were involved with moon, indicate that the moon factor is not linked to stipple but belongs to the same group as one-spot, twin-spot and crescent. In one of the crosses, number 13, twenty-nine moon-platys (non-stippled) were obtained. In each of these, the three elements, moon proper and the two satellites, were present. In neither this nor any other cross did individuals of the moon pattern appear which did not have these three elements. Yet in some of Meek's specimens it seems as if the moon part sometimes appears alone. The significance of this is not yet clear.

The Hereditary Factor for the Crescent Pattern

The crescent-platy as obtained from a fish-dealer also had the stippling pattern. In a series of crosses to the double recessive, the Gold-platy, it was quite easy to derive the crescent, non-stippled type. A study of these crosses, listed in Table VI, indicates clearly that there is no apparent linkage between the crescent and stipple factors. There is a more definite relation, however, between crescent and the patterns one-spot, twin-spot and moon, as indicated by crosses listed in Table VII.

The crescent pattern appeared 316 times in the course of these experiments, and in each case the pattern remained duplex, containing both the anterior battle ax portion (C^b), and the posterior crescent piece (C^c). In the specimens collected by Meek the two

---

EXPLANATION OF FIGURE 6

A—The One-Spot, Moon Pattern

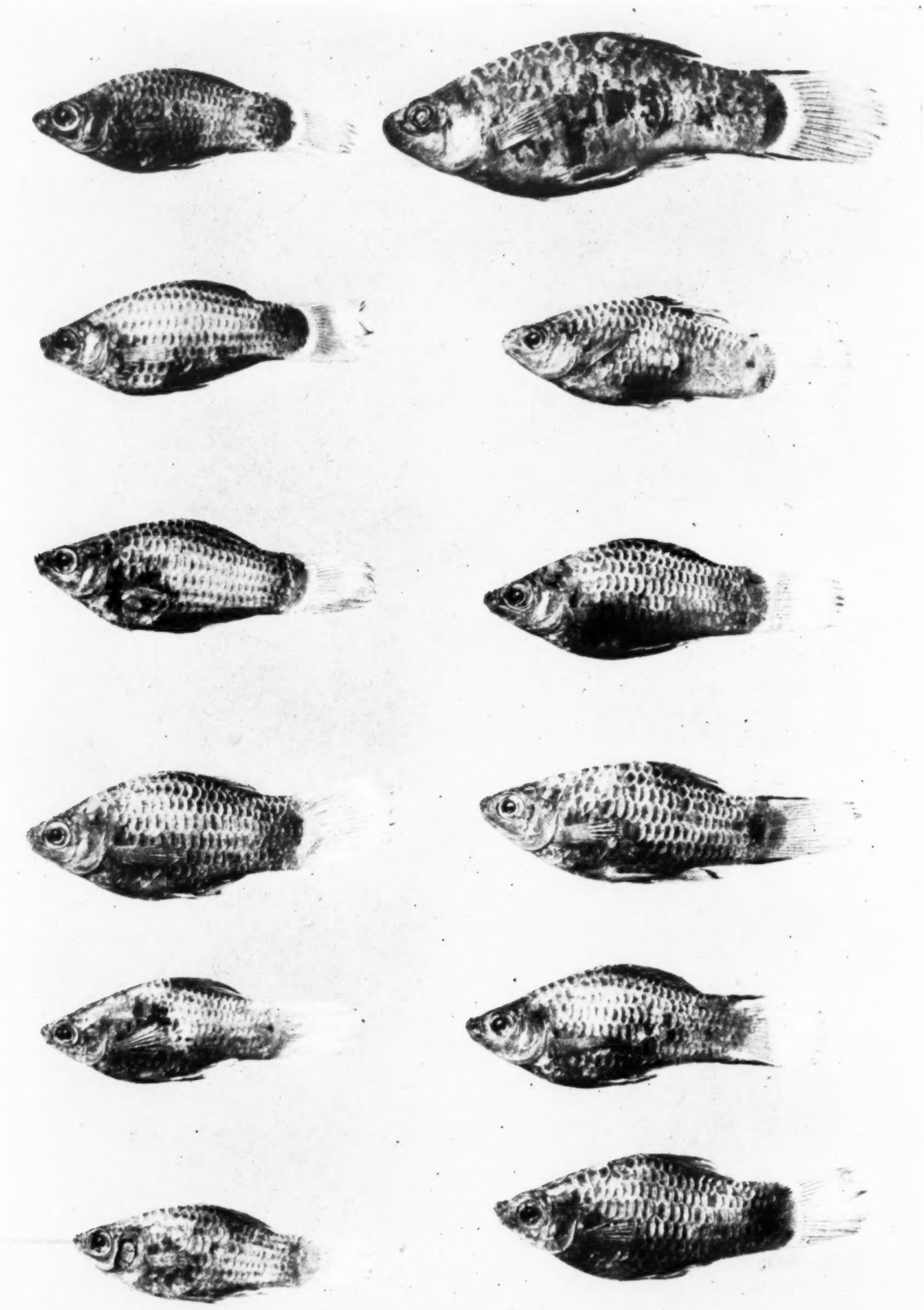
Photograph of a cleared 16 mm. one-spot, moon (stippled platy). This specimen is younger than the others. This accounts for the lesser degree of pigmentation both for the moon and one-spot patterns. Difficulty is sometimes experienced in recognizing this combination in older animals, but these are quite clear at this age.
M.s., Satellite of moon.
O., One-spot
M.p., Moon pattern.
St., Stipple or micromelanophore.

B—The One-Spot, Crescent Pattern

Photograph of a cleared 16 mm. (immature) one-spot, crescent (gold platy). At this stage both patterns may be recognized but in older specimens, the two patterns fuse and it becomes difficult to recognize the combination. In cross sections of older specimens the patterns can be separated.
C.c., Crescent part of crescent pattern.
O., One-spot pattern.
C.b., Battle ax part of crescent pattern.

C—The Rubra Platy With the One-Spot Pattern

Photograph of a cleared rubra platy from which the one-spot pattern was finally isolated.
O., One-spot pattern.
St., Micromelanophores of the stippling pattern.
Sp., Macromelanophores of the spotted pattern.



THE PLATYFISHES COLLECTED BY S. E. MEEK IN 1904

Figure 7

The plate published by S. E. Meek in 1904 to illustrate "the most variable fresh water fish in Mexico with respect to color markings." The fishes have the following patterns determined by genetical studies of comparable patterns in aquarium reared individuals. (Read down.)

1. St Stippled
   Sp Spotted
   C Crescent
2. St Stippled
   O One-spot
   C Crescent
3. St Stippled
   O One-spot
   C Crescent
4. St Stippled
   Sp Spotted (black?)
   O One-spot

Explanation concluded on next page

parts of the crescent pattern were found separately as many times as they were found together. The occurrence of the C^b and C^c patterns separately in the wild fishes may indicate that there are two primary factors rather than one concerned in the hereditary control of the crescent complex.

The Crosses to Get Double Dominant Combinations*

Up to this point the four autosomal factors have been found to be independent of the stippling factor. The next series of crosses was made for the purpose of studying the linkage relations between them. This was done by crossing fishes showing different patterns together to get double dominant combinations. The latter were then back-crossed to the double recessives.

The first indication of a definite genetic relationship between some of the factors for patterns in the caudal peduncle was manifest in the progeny of males which were both one-spotted and twin-spotted with gold-platy females which were double recessive (cross number 23). There were 88 one-spots and 106 twin-spots, no double dominants nor double recessives. This would indicate either an absolute linkage or an allelomorphic relationship. When a one-spot, twin-spot platy was the female parent (OT) and the double recessive was the male parent, similar results were obtained, but with a few exceptions. There were 78 one-spots (O), 78 twin-spots (T), no double recessives, but there were 4 double dominants (OT). The four may be crossover types or they may represent individuals resulting from some form of chromosome aberration. If the latter be true, allelomorphism may still apply. Further discussion will be presented later.

The other double dominants (OM, OC, TM, TC, and CM) were backcrossed to fishes lacking the particular combination found in the individuals to be tested (for details see Table VIII). The results of these crosses, without exception, show that the pattern combinations found in the offspring were unlike the combinations seen in their respective parents. Complete segregation took place in all crosses. In this connection the crosses number 26, 30 and 32 are of particular interest:

Parents: Female	Male	Kinds of Progeny
OT	$\times MC$	$= OM\ OC\ TM\ TC$
OM	$\times TC$	$= OT\ OC\ TM\ MC$
TM	$\times OC$	$= OT\ OM\ TC\ MC$

These results suggest more clearly than before that the four color pattern factors of this series apparently belong to the same allelomorphic group. Yet it cannot be said with certainly

	*Combination obtained		*Cross number*	*Table*	*Fig. No.*
1.	One-spot, Twin Spot	(O T)	19	5	3*C*
2.	One-spot, Moon	(O M)	24	6	6*A*
3.	One-spot, Crescent	(O C)	25	6	6*B*
4.	Twin-spot, Moon	(T M)	24	6	5*B*
5.	Twin-spot, Crescent	(T C)	20	5	5*A*
6.	Crescent, Moon	(C M)	21	5	4*C*

EXPLANATION OF FIGURE 7

5. St Stippled
   Sp Spotted
   O One-spot
6. St Stippled
7. St Stippled
   Sp Spotted (black?)
   Cc Crescent (crescent)
8. St Stippled
   O One-spot
   C Crescent
9. St Stippled
   T Twin-spot
10. St Stippled
    O One-spot
11. St Stippled
    Sp Spotted
12. St Stippled
    M Moon

This plate is reproduced here through the courtesy of Director S. C. Simms of the Field Museum of Natural History, Chicago, Ill.

Table III

Cross number	Females: Pattern	Symbols	Pedigree	Males: Pattern	Symbols	Pedigree	Progeny: Culture number	O,St	O,st	o,St	o,st
1.	One-spot, Stipple.	Oo,Stst	15-2	Non-one-spot, Stipple.	oo,Stst	20-11	52	14	3	11	5
2.	One-spot, Stipple.	Oo,Stst	33-2	Non-one-spot, Non-stipple.	oo,stst	43-12	82	4	4	6	0
3.	One-spot.	Oo	52-3	Non-one-spot,	oo	40-12	115	0	11	0	10
4.	One-spot, Stipple.	OO,StSt	66-1	Non-one-spot, Stipple.	oo,StSt	66-13	104	63	0	0	0
5.	Non-one-spot, Non-stipple.	oo,stst	40-1,2 71-1	One-spot, Stipple.	OO,StSt	66-11 66-14	101,102 107	52 39	0 0	0 0	0 0

Table IV

								T,St	T,st	t,St	t,st
6.	Non-twin-spot, Stipple.	tt,Stst	15-1	Twin-spot, Stipple.	Tt,Stst	16-11	58	10	1	7	1
7.	Twin-spot.	Tt	58-2	Non-twin-spot.	tt	43-13	84	0	32	0	29
8.	Non-twin-spot, Non-stipple.	tt,stst	43-22	Twin-spot, Stipple.	Tt,Stst	64-12	103	7	7	7	5
9.	Twin-spot.	Tt,	103-1	Non-twin-spot.	tt,	52-31	114	0	9	0	7

Table V

								M,St	M,st	m,St	m,st
10.	Moon, Stipple.	Mm,StSt	66-	Moon, Stipple.	Mm,StSt	66-	66	109	0	59	0
11.	Non-moon, Stipple.	mm,StSt	66-2	Moon, stipple.	Mm,StSt	66-13	110	8	0	11	0
12.	Non-moon, Non-stipple.	mm,stst	40-3	Moon, Stipple.	Mm,Stst	66-14	111	6	0	4	6
13.	Non-moon, Stipple.	mm,Stst	108-2	Moon, Stipple.	Mm,Stst	110-11	148	11	29	11	22

Table VI

								C,ST	C,st	c,St	c,st
14.	Crescent, Stipple.	Cc,Stst	22-1 22-2	Non-crescent, Stipple.	cc,Stst	20-11	48 49	19	4	15	5
15.	Non-crescent, Stipple.	cc,Stst	48-3	Crescent, Stipple.	Cc,Stst	48-31	96	16	3	15	4
16.	Non-crescent, Non-stipple.	cc,stst	43-9 43-10	Crescent, Non-stipple.	Cc,stst	48-11	90 91	0	41	0	47
17.	Non-crescent, Non-stipple.	cc,stst	43-21	Crescent, Stippled.	Cc,Stst	48-31	95	15	21	17	19
18.	Crescent, Stipple.	Cc,StSt	48-3 48-4	Crescent, Stipple.	Cc,Stst	48-31	97 98	73	0	31	0
19.	Crescent, Stipple.	Cc,Stst	48-1 48-2	Crescent, Non-stipple.	Cc,stst	48-11 48-11	92 93	11	19	8	3

Table VII

								TO	Op*	Tp*	pp*
20.	One-spot.	OO	66-1	Twin-spot.	Tt	88-11	105	15	10	0	0
21.	Twin-spot.	Tt	114-1	Crescent.	Cc	108-11	117	TC 11	Tp 11	Cp 6	pp 12
22.	Crescent.	Cc	108-2	Moon.	Mm	110-11	148	CM 19	Cp 21	Mp 17	pp 16

Table VIII

								OT	Op	Tp	pp		
23.	Non-one-spot, Non-twin-spot.	pp	52-1 60-1	One-spot, Twin-spot.	OT	105-11	138,139 142.	O	88	106	0		
24.	One-spot, Twin-spot.	OT	66-5 105-1	Non-one-spot, Non-twin-spot.	pp	60-11 132-11	141,143 144	4	78	78	0		
25.	One-spot, Twin-spot.	OT	105-5	Moon.	Mp	110-11	158	OM 7	TM 2	Op 2	Tp 5		
26.	One-spot, Twin-spot.	OT	105-6	Moon, Crescent.	MC	148-11	159	OM 7	TM 7	OC 8	TC 3		
27.	One-spot.	Op	150-1	Moon, Crescent.	MC	148-11	160	OM 2	OC 3	Mp 0	Cp 1		
28.	Moon, Crescent.	MC	164-1	Non-moon, Non-crescent.	pp	148-12	174	MC 0	Mp 10	Cp 5	pp 0		
29.	Non-twin-spot, Non-crescent.	pp	66-6	Twin-spot, Crescent.	TC	117-11	147	TC 0	Tp 13	Cp 12	pp 0		
30.	One-spot, Moon.	OM	158-1	Twin-spot, Crescent.	TC	117-11	162	OT 4	OC 2	MT 1	MC 3		
31.	Twin-spot, Moon.	TM	162-1	Non-twin-spot, Non-moon.	pp	148-13	175	TM 0	Tp 3	Mp 2	pp 0		
32.	Twin-spot, Moon.	TM	162-2	One-spot, Crescent.	OC	160-11	164	OT 2	OM 1	MC 3	TC 4		

* p refers to absence of pattern in caudal peduncle and is identical with o, t, m, and c of previous tables

that this is actually the true situation because of the lack of sufficient numerical data in each type of cross described.

With regard to the four exceptions occurring in cross number 24, if the view be taken that these four represent cross-over types it may be pointed out that it is strange that all should have appeared in only one of the four possible classes. The double dominant and recessive classes of cross number 23 were not represented, nor was the double recessive class of cross number 24. Unfortunately further experiments to determine the true situation were made impossible because of the complete sterility in each of the four exceptional individuals. Three of them were females; each was placed with a number of males of known fertility but there was no issue. The fourth was a male and although ten different females were tried with it, at different intervals, no young resulted.

In view of the sterility of all the exceptional fishes, it appears not unlikely that some type of abnormal chromosome distribution had occurred, like non-reduction of chromosomes, in the one-spot, twin-spot (OT) female parent. In all other crosses the factors O and T appear allelomorphic to each other and to M and C. Therefore, tentatively at least, multiple allelomorphism will be held to govern this series of factors, all of which concern the development of micromelanophores and the formation of various types of patterns in the caudal peduncle.

Having come to the above conclusion it will be necessary to refer to these various hereditary factors as follows:

P refers to pigment in caudal peduncle.
P^O refers to the one-spot pattern.
P^T refers to the twin-spot pattern.
P^M refers to the moon pattern.
P^C refers to the crescent pattern.
p refers to no pigment in the caudal peduncle.

Color varieties like the gold-platy and the stipple-platy are recessive for the caudal peduncle patterns and may be referred to as p, genetically. The spotted-platy and the black-platy are usually recessive for this series but they may be dominant for some of them. This can only be determined by a breeding test because these two spotted patterns are epistatic to the four peduncle patterns.

General Discussion

Attention has been called recently by Haldane[11] and by Fisher[4] to the significance of the genetic basis for polymorphism in certain insects, molluscs and fish. The general characteristics are given by Fisher as follows. The *wild* forms are polymorphic. The polymorphism may in each case be shown to be determined by genes or gene complexes which are closely linked in inheritance. Each species has a relatively common "universal recessive." The last statement indicates that polymorphism is usually determined by a series of hereditary factors which behave as dominants.

A study of the sixty-eight specimens of *Platypoecilus maculatus* collected by Meek living in the feral state in Mexico, together with the knowledge of the genetical work here and elsewhere described, indicates that Platypoecilus exhibits a type of polymorphism and dominance phenomena comparable to that described for Nabours' ground locusts, for Diver's snails and Winge's fish.

It is desirable to indicate the status of the polymorphism phenomenon as it is found in Platypoecilus. For this species Gordon[9] has described sixteen color patterns from aquarium reared material. With the exception of one of these, the gold-platy, all of these forms have been found to have exact counterparts among their Mexican progenitors. Up to the present time eight of the color patterns have been referred to the activity of eight definitely determined genetic factors, seven of which are dominant. There are three sex-linked dominant factors which are held to be allelomorphic by Bellamy[1, 2] but which are considered closely linked by Fraser and Gordon.[6, 7] In addition,

there are five autosomal factors which have been divided into two autosomal linkage groups; four of these factors, those described in the present paper, are dominant and apparently allelomorphic, the fifth shows independent inheritance and may be regarded as a recessive to the wild type.[8]

It is interesting to note that the recessive forms, the gold-platy, was detected in aquarium reared specimens. There are no representatives of the gold-platy type in Meek's Mexican-caught material of *Platypoecilus maculatus*. Over a thousand specimens of the three other species of *Platypoecilus* (*couchianus, xiphidium* and *variatus*) were collected by the senior author in Mexico in 1930, yet there was found no comparable gold-platy pattern among them. The origin of the gold-platy in aquarium reared cultures is traced by Gordon[9] and concerns the mutation of the dominant (wild) gene *St* for stippling to the recessive *st*, the gold pattern.

Platypoecilus differs markedly from Lebistes with respect to sexual dimorphism within the species. In the latter there is a strong sexual dimorphism in response to practically all of the twenty-three genes for color patterns (Winge,[13] Blacher[3]). In *Platypoecilus maculatus* there is only a partial dimorphism in response to only one gene, *R* for red body color. The red pigment cells are developed to a greater degree in males than in females, although in recent selection experiments, females have been obtained fully as red as the males. Unfortunately there is no information on the frequency of the red pattern in naturally occurring specimens. With respect to the other patterns due either to sex-linked or to autosomal factors, there is no sexual dimorphism.

The color patterns are divided fairly well between the two sexes in Platypoecilus as reference to Table II will indicate. Certain patterns occur more frequently than others but lack of sufficient collections over the entire range of Rio Papaloapam makes it impossible to attach too much significance to the facts at hand.

Summary

Four melanic patterns are described which occur in aquarium reared specimens of *Platypoecilus maculatus*. These patterns are found represented in the progenitors of the aquarium fishes. This is made evident by the study of the specimens collected by Meek in Mexico.

Each of the four patterns develops in response to a dominant autosomal gene. The four patterns have been called One-spot *O*, Twin-spot *T*, Moon *M* and Crescent *C*. Genetical experiments have given some evidence that these four dominant factors form an allelomorphic series.

Attention has been called to the fact that the phenomenon of polymorphism is found in *Platypoecilus maculatus*.

Literature Cited

1. Bellamy, A. W., 1922. Sex linked inheritance in the teleost *Platypoecilus maculatus* (Günther). *Anat. Rec.* 24: 419-420.

2. ————, 1928. Color pattern inheritance and sex in *Platypoecilus maculatus* (Günther.) Genetics 13: 226-232.

3. Blacher, L. J., 1928. Material on the genetics of *Lebistes reticulatus*. *Trans. Lab. Exp. Biol. Zoopark Moscow* 4: 244-252.

4. Fisher, R. A., 1930. The evolution of dominance in certain polymorphic species. *American Nat.* 64: 385-406.

5. Fraser, R. A., and Myron Gordon, 1928. Crossing over between W and Z chromosome of the killifish, *Platypoecilus maculatus*. *Science* 67: 470.

6. ————, 1928. A third linkage group in the killifish, Platypoecilus. *Anat. Rec.* 41: 106.

7. ————, 1929. The genetics of Platypoecilus. II. The linkage of two sex linked characters. *Genetics* 14: 160-179.

8. Gordon, Myron, 1927. The genetics of a viviparous top-minnow Platypoecilus; the inheritance of two kinds of melanophores. *Genetics* 12: 253-283.

9. ————, 1931. Morphology of heritable color patterns in the Mexican killifish

Platypoecilus. *Amer. Jour. of Cancer* 13: 732-787.

10. GUNTHER, H., 1866. Catalogue of Fish. British Museum 6: 1-350.

11. HALDANE, J. B. S., 1930. A note on Fisher's theory of the origin of dominance and linkage. *Amer. Nat.* 64: 87-90.

12. MEEK, S. E., 1904. The fresh water fishes of Mexico north of the isthmus of Tehuantepec. *Field Col. Mus. Zool.* Series 5: 1xxiii+252.

13. WINGE, O., 1927. The location of eighteen genes in *Lebistes reticulatus*. *Jour. f Genetics* 18: 1-43.

Books Received

BOOKS are acknowledged in this column as received, and such acknoweldgment must be regarded as sufficient return for the courtesy of the sender. As far as space permits, books that contain material of special interest to the readers of the JOURNAL *will be reviewed in later numbers.*

BIOLOGY IN HUMAN AFFAIRS, *Edited by* E. M. EAST. Twelve contributors Pp. XI+399. 12 Chapters. Price $3.50. McGraw-Hill Book Company, New York. 1931.

A twelve-angled statement of the way the science of life infringes on the affairs of Homo sapiens.

PREPARATION OF SCIENTIFIC AND TECHNICAL PAPERS, *by* SAM F. TRELEASE, Professor of Botany in Columbia University, and EMMA SAREPTA YULE, Head Department of English in College of Agriculture, University of the Philippines. Pp. 117. Williams and Wilkins Company, Baltimore. 1930.

A book that every editor will heartily wish on the desk of every research man about to commit authorship. Nothing is said about the unforgivable misdemeanor of attaching things to photographs or photographs to things with paper clips—an omission that convinces us that the authors have not toiled to eliminate the resulting irremovable corrugations.

THE MOTHERS, The Matriarchal Theory of Social Origins, *by* ROBERT BRIFFAULT. Pp. 319. 12 Chapters. Price, $4.00. The Macmillan Co., New York. 1931.

A relatively brief résumé of Briffault's two-volume exposition of the predominant, nay exclusive, part that the more deadly sex has had in the development of civilization. With civilization in the "fix" it is right now, perhaps the joke is on the ladies, after all!

RACE MIXTURE, Studies in Intermarriage and Miscegenation, *by* EDWARD BYRON REUTER, Professor of Sociology, University of Iowa. Pp. 224. 9 Chapters. Price, $2.50. McGraw-Hill Book Company, Inc., New York. 1931.

Another volume by a sociologist who is doing his bit to "solve" the race problem by the scramble-egg method.

THE PROBLEMS OF EVOLUTION, *by* ARTHUR WARD LINDSEY, Professor of Zoology in Denison University. Pp. 236. 8 Chapters. Price, $2.00. The Macmillan Company, New York. 1931.

Stock-taking of available *facts* regarding evolution. Hopeless inadequacy of experiments on effect of environment stressed. "The inheritance of acquired characters is emphasized because it demands investigation more than any other subject, but it is broader than the term usually implies.

KUNSTLICHE GESCHLECHTSUMWANDLUNGS-KREUZUNGS- UND BEFRUCHTUNGS-VERSUCHE BEI FISCHEN, *by* DR. HERBERT SCHMIDT. Pp. 107. 36 Illustrations. Verlag "Das Aquarium," Berlin. 1930.

Excellently illustrated with pictures of species and genus fish hybrids, and containing a list said to comprise all experimental fish crosses. Good illustrations of platy hybrids.

SOME MORE MEDICAL VIEWS ON BIRTH CONTROL, *edited by* NORMAN HAIRE, Ch. M., M. B. Eleven Contributors—Barr, Bourne, Crew, Eder, Goddard, Haire, Hawthorne, Jacobs, Lane, Smith, Stone. Pp. 216. 11 Chapters. Price, $2.50. E. P. Dutton & Co., Inc., New York. 1928.

The "pro" medical viewpoint, variously presented, the "cons" having got their noses under the wire with "Some Medical Views" a few months before. Haire's remarks on the difficulties of intellectual treatment of the subject, as contrasted with the almost unanimous emotionalism of both pros and cons, and his first-hand notes on the questionable joys of being a junior member of a large family, especially interesting.

THE PHYSICAL BASIS OF PERSONALITY, *by* CHARLES R. SOCKARD, M. D., Professor of Anatomy. Pp. 320. 16 Chapters. 73 Illustrations. Price, $3.50. W. W. Norton & Company, New York. 1931.

What years of study of dogs and their endocrines has taught Dr. Stockard, and has suggested to him about men and *theirs*.

SEX HYGIENE AND REPRODUCTION OF CATTLE, *by* W. W. WILLIAMS, A. B., D. V. M., Specialist in Reproductive Diseases of Cattle. Pp. 252. 10 Chapters. 55 Illustrations Published by the Author, Springfield, Mass. 1930.

What every cow should know. Well illustrated. "Reproduction" covered only in its physiological and veterinary phases. No cytology or genetics.

A NEW THEORY OF HEREDITY, *by* GEORGE ARTHUR GASKELL Pp. 93. Price, 2/6 net. C. W. Daniel Company, London. 1931.

Etheric forces, etc., etc., etc., substituted for the unsatisfactory, elusive gene with the following convincing and satisfying result:

A good example of the adaptability of cell-plasm is the following: "Mme Bisson describes how on May 25th, 1921, at 4:30 P. M., a beautiful little naked female, only eight inches high, fashioned itself gradually from a mass of ectoplasm on the medium's hand in full view. It had long hair and its skin was brilliantly white in the daylight which flooded the room It vanished, but reappeared immediately with the hair differently arranged. It again disappeared but returned and was now only six inches high. Its anatomy seemed to be perfect, for it went through various gymnastic exercises [crossing over? *Ed.*], and finally stood on Mme Bisson's hand. There were six sitters at this seance." (*Psychic Science*, A. C. Holmes, p. 370.)

We challenge all geneticists and cytologists to bring forward any chromosomes that will show *such* adaptability, or stand on Mme. Bisson's hand, either.

L'HEREDITE, *by* PROFESSOR E. GUYENOT. Pp. 470. 47 Figures. Price 30 fr. Gaston Doin & Cie., Paris

LA PARTHENOGENESE, *by* A. VANDEL, Professeur a la Faculte des Sciences de Toulouse. Pp. 414. 42 Figures. Price 32 fr. Gaston Doin & Cie., Paris.

L'OEUF ET LES FACTEURS DE L'ONTOGENESE, *by* A. BRACHET, Professeur a la Faculte des Sciences de Paris. Pp. 438. 59 Figures. Price, 32 fr. Gaston Doin & Cie., Paris.

Three additions to a French series that has had some excellent numbers.

THE LABORATORY MOUSE, Its Origin, Heredity, and Culture, *by* CLYDE E. KEELER, Sc. D., Research Fellow of the Howe Laboratory, Harvard Medical School. Pp. 81. 7 Chapters. 36 Illustrations. Harvard University Press, Cambridge. 1931.

A mousologist's *Vade Mecum*. The ritual of the mouse cult of *Apollo Smintheus*, popular at the time of Alexander the Great, probably sounded as intelligible to the layman as the getting-together of a pair of mouse geneticists, but what a contrast in the potentialities of increased knowledge, and ultimately, of benefit to mankind!

DISCOVERING OURSELVES, A view of the Human Mind and how it Works, *by* EDWARD A. STRECKER, A M., M. D., and KENNETH E. APPEL, Ph. D., M. D. Pp. 306. 2 Parts, 21 Chapters. Price, $3.00. The Macmillan Company, New York. 1931.

Another voyage to the Inward See. This form of discovery is the most satisfactory known to man because every explorer brings back another and altogether different set of priceless relics!

COLLECTED PAPERS ON EUGENIC STERILIZATION IN CALIFORNIA, A Critical Study of Results in 6,000 Cases. With an Introduction by E. S. GOSNEY. 26 Papers. The Human Betterment Foundation, Pasadena, California. 1930.

A set of the reprints of the published reports of study of the California sterilization law, made possible by the author of the Introduction. A limited issue that should be valuable in reference libraries.

THE DEVELOPMENT OF CHARACTER TRAITS IN YOUNG CHILDREN, *by* AMELIA MCLESTER, Assistant Professor of Education, University of Virginia, and Supervisor of Rural Schools, Albemarle County, Virginia. Pp. 126. 20 Chapters. Price, $1.25. Charles Scribner's Sons, New York. 1931.

An experiment in moral education. The above-mentioned "fix" in which civilization finds itself suggests that the results Miss McLester reports should encourage verification and other experiments along the same line. The recent statement of President Hutchins of Chicago University that our system of education is directly responsible for conditions viewed with justifiable alarm has much in its favor. There is no particular purpose in trying to improve the quality of human genes if we do not develop the genes already to hand.

"Plant Breeding Abstracts"

THE Imperial Bureau of Plant Genetics has begun to issue a publication entitled *Plant Breeding Abstracts* in which all the more important current publications dealing with plant breeding and the genetics of crop plants (other than herbage!) are listed. The references are classified according to subject and each reference is followed by an abstract indicating the subject matter of the paper and the results obtained. The papers are divided into two groups, those published in the British Empire and those published in other countries. Papers written in foreign languages are usually abstracted somewhat more fully than papers in English.

Plant Breeding Abstracts is issued quarterly and Vol. 1, No. 3, which was published on April 1, 1931, contains 197 references covering 52 pages.

The annual subscription for the publication is at present five shillings—post free, single copies being obtainable at the price of 1/6. Subscriptions should be sent to the Deputy Director, Imperial Bureau of Plant Genetics, School of Agriculture, Cambridge, England.

Heterosis In Guinea Pigs

IT may be possible some day for the livestock producer to breed his animals in such a way as to speed up the growth of their offspring. Scientists of the United States Department of Agriculture have accomplished this with guinea pigs and believe the same principles may apply to livestock.

Dr. Hugh C. McPhee, geneticist of the Bureau of Animal Industry, and his associates observed that inbreeding and crossbreeding of guinea pigs exerted a marked influence on the rapidity or slowness of the offspring's growth. They are starting new researches to test these scientific principles of in-

heritance on livestock, especially swine, sheep, and cattle.

If the livestock breeder could influence the rate of growth of his young farm animals as has been done with guinea pigs he would have control of an important element in the cost of production. It is generally accepted that rapid growth is economical growth.

The department scientists obtained various results by crossbreeding the members of unrelated families of guinea pigs, each of which had been thoroughly inbred. When both parents were members of light-weight families the offspring grew faster and larger than either parent at the same age. When one parent was a light weight and the other a heavy weight the offspring grew more nearly like the heavy-weight parent, gaining especially fast in case the mother was the heavy weight. The investigators gained no advantage of growth by crossing two heavy-weight families, but did improve the fertility of the offspring. The heaviest family of inbred guinea pigs outgrew all others during their first four months.

U. S. Dept. Agr. Clip Sheet.

Livestock Breeding In Russia

ONE of the most important problems of agriculture in the USSR is cattle breeding. The fact that the consumption of meat by the working population of the USSR from 1925 to 1930 grew by 25 per cent, and by the peasant population even by 40 per cent, is sufficient proof for this. On the other hand the enormous growth of industries of the USSR, which require raw materials, makes it necessary to stimulate cattle breeding.

The State is, therefore, attaching considerable importance to this problem. Last year alone hundreds of State cattle breeding farms were set up in which large funds were invested.

This year the investments for the organization of live-stock farms will be considerably increased in comparison with last year.

The USSR ranks second according to the number of head of cattle. In 1930 the total head of cattle constituted 53 million. Last year "Skotovod" (the Stock-Breeding Trust) organized 140 meat State farms, occupying an area of 20,000,000 hectares. On the average one meat State farm occupied about 140,000 hectares. "Skotovod" applies modern methods in growing, feeding, tending and keeping cattle, which is possible only in large State and collective farms.

In 1930 the number of horses in the USSR reached the pre-war figure of 31 million. Special attention has been paid during the current year to the development of high breed horses, for which purpose 75 State horse farms with 20,000 of the best breeds of horses have been set up. It is very significant that Soviet horses in Germany in 1929 received first prize. Out of the total number of horses 20,000,000 are working horses.

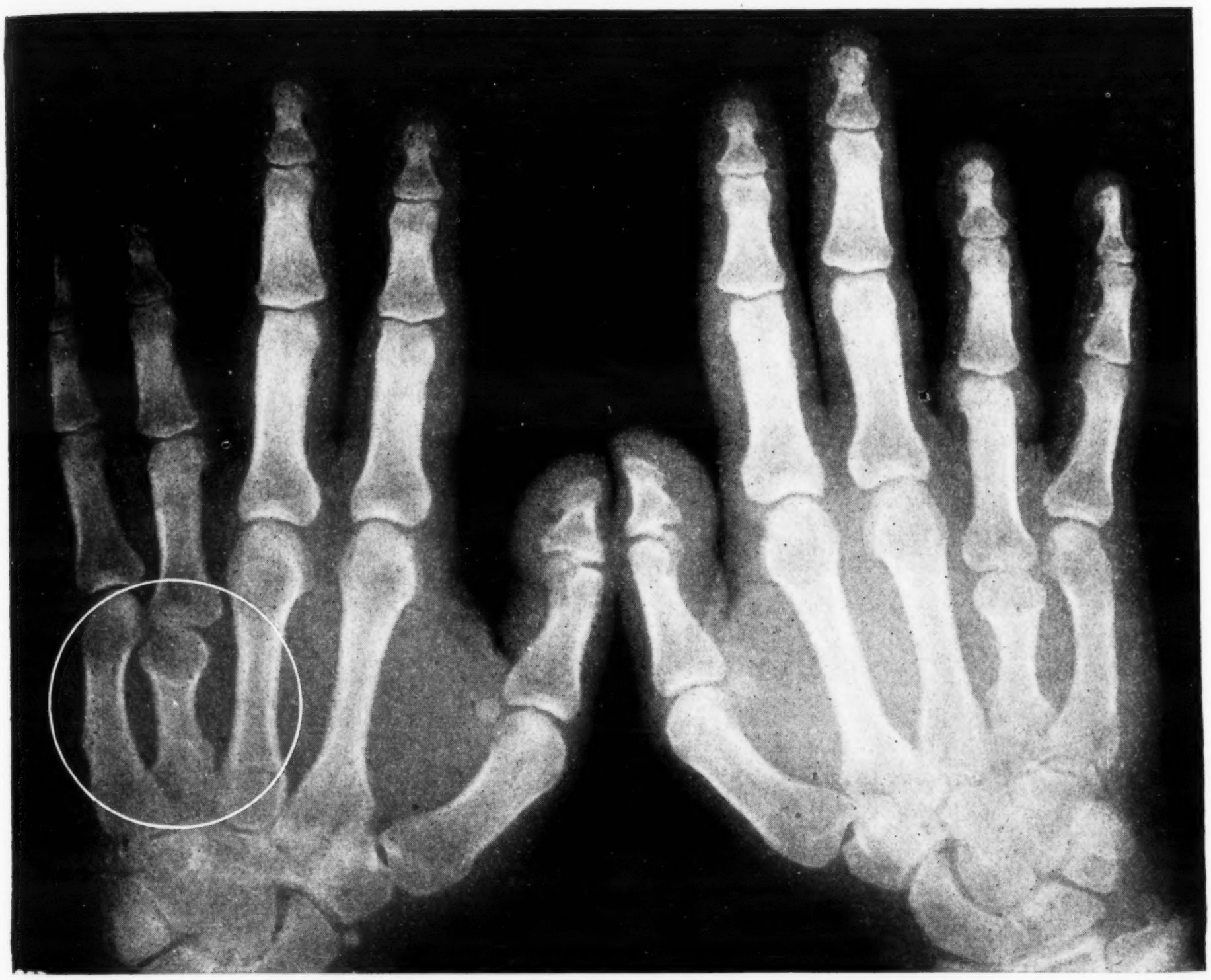
The number of hogs in 1930 amounted to about 12,500,000 head. At the beginning of this year 340 State hog farms have been organized. The number of sheep in 1930 amounted to 90,000,000 head. "Ovtzevod" (the Sheep Trust) numbers at present 132 State farms occupying a territory of 20,000,000 hectares.

USSR Five-Day Bulletin of Economic Information.

AN INHERITABLE DEFECT OF THE HUMAN HAND

C. P. GILLETTE

Colorado Agricultural College



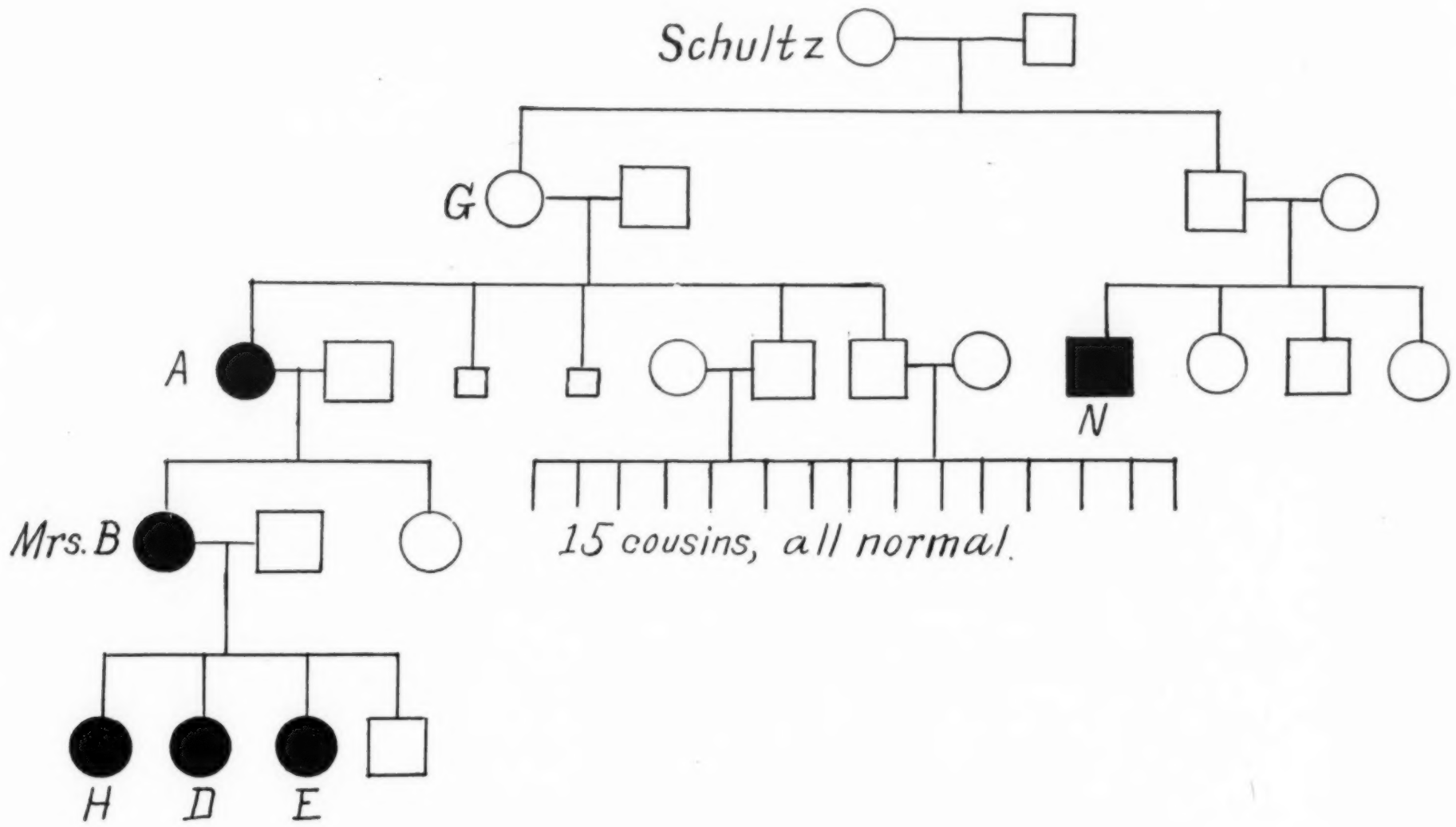
SHORT METACARPALS OF THE RING FINGER

Figure 8

A dominant gene that affects one bone in one finger of each hand is an excellent example of the minute detail in activity displayed by these carriers of heredity.

SEVERAL years ago Dr. W. A. Kickland of Fort Collins, gave me an X-ray negative which he had taken of an hereditary defect in the human hand, the like of which I had never seen. From a personal interview at the time, and several letters written recently, I have gathered all possible information concerning the inheritance of this defect, which is shown in Figure 8. Notice the short third finger occurring in both hands, and also notice that the shortness is due, not to the length of the finger bones, but to the shortening of the metacarpal bone.

In the diagram, Figure 9, I have charted the appearance of this characteristic through three generations, as given me by Mrs. B., whose hands



INHERITANCE OF THE SHORT METACARPALS

Figure 9

The character varies in expression. In one instance (*D*) the little finger is also short. The toes do not appear to be affected.

were photographed. In all cases the defect appeared in both hands and was not noticed in any case before the children were seven years of age. In the case of Dorothy (*D*), the middle or second finger is also short, and in the case of Edith (*E*), the little finger is shortened along with the third finger. Mrs. B. reports all toes normal so far as she can learn, except that in case of the fourth toe on her left foot, which is noticeably short.

Mrs. B. attributes the increase of this defect in her family to her marriage back into German stock, where the defect first occurred.

This defect is one in which the family has taken considerable interest since the grandmother (*G*) noticed the short fingers of her daughter (*A*), and which at first was thought to be a birth mark. This, however, the grandmother resented and believed that it was due to the daughter forcing rings, which were too small for her, upon these fingers. This theory had to be given up, however, when the grandmother found that one of her nephews (*N*) also had the same short fingers.

That this characteristic is a Mendelian dominant seems quite certain and the mutation in the germ plasm must go back as far, at least, as the two ancestors by the name of Schultz, who came to this country from Germany about 1840 and settled near Detroit, Michigan, but neither of whom apparently developed this short finger character, as the daughter (*G*) was greatly disturbed about its appearance in her daughter (*A*) and which she could only account for by thinking that the daughter had dwarfed her fingers by forcing rings upon them.

NEMATODE-RESISTANCE STUDIES WITH POLE SNAP BEANS

C. L. Isbell

Alabama Agricultural Experiment Station

THE roots of most varieties of garden beans grown in nematode-infested soils in the South are injured by this pest. In sandy soils where many susceptible vegetables are grown and where rotation with resistant plants is not practiced the roots of beans are often so severely damaged as either to kill the plants or greatly weaken them. Varieties of cowpeas[1], soy beans[2], and velvet beans[3] that are resistant or immune to nematode are known, but resistant or immune varieties of garden beans are not known, or if known are not catalogued as such. Experiments were started in 1928 to determine whether nematode-immune varieties or strains of pole snap beans existed and, if so, to develop by selection those immune varieties or strains that produce satisfactory yields of beans of good quality.

Experimental Studies

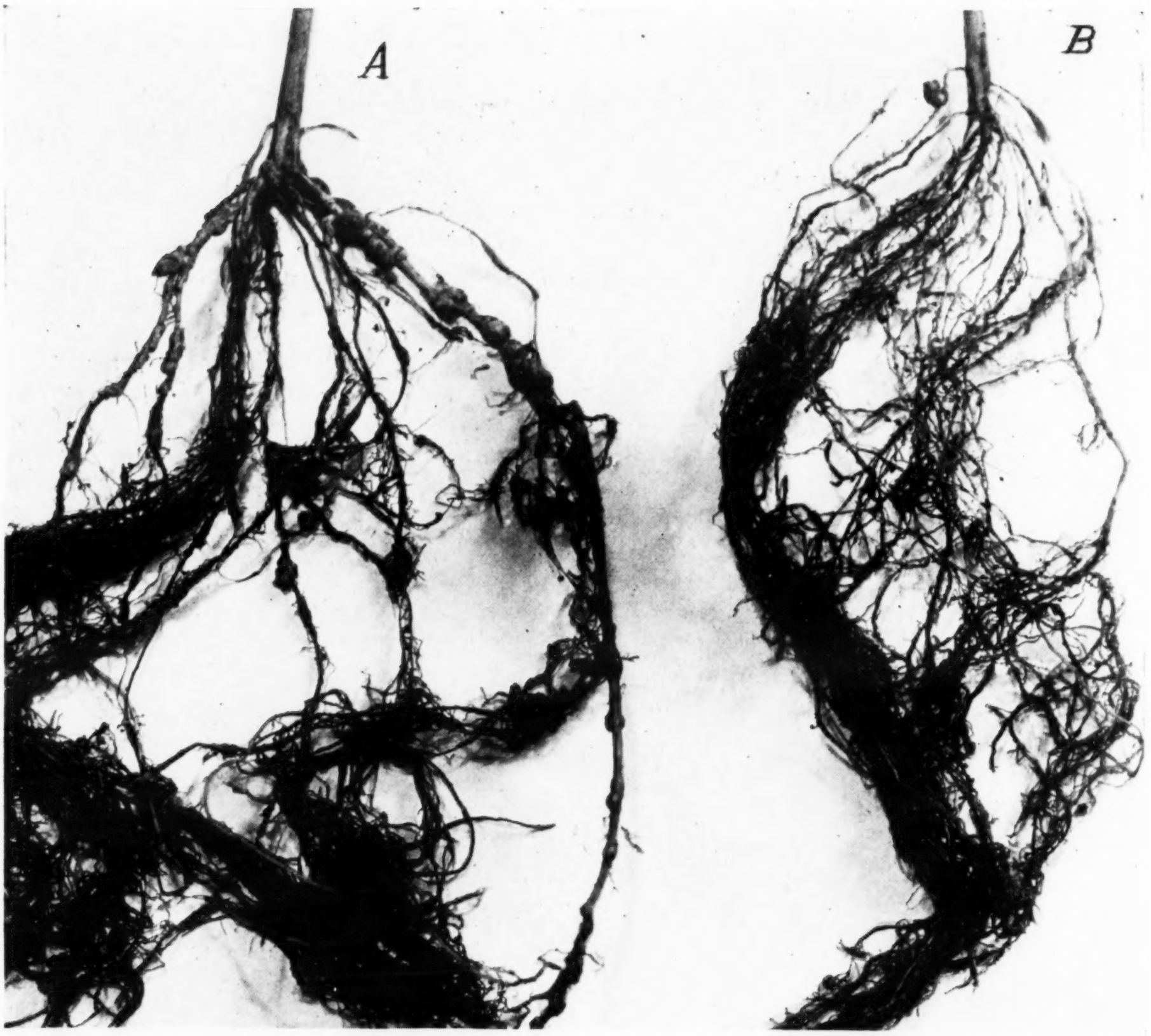
Preliminary experiments were started by growing, in nematode-infested soils under field conditions, many standard varieties and a few selections, which had been obtained by scouting farm gardens for promising plants. The results obtained during 1928 and 1929 indicated that some of the standard varieties, especially Creaseback, Ideal Market, and Kentucky Wonder, might respond to selection for resistance. Certain of the selections* from un-named varieties or strains were found highly resistant, if not immune, and compared favorably in yield and quality with standard varieties. To make a more thorough study of a standard variety and a limited number of selections, plants were grown under five different conditions during 1930.

Experiment I. In this experiment comparisons were made of the resistance of Kentucky Wonder and each of three different selections. The experiment was conducted in the greenhouse in soil heavily infested with nematode. The experiment was started on April 16. Each kind was grown separately in two-gallon pots, two plants to the pot; each selection was also grown separately in the same pot with Kentucky Wonder, one plant of each to the pot. All treatments were triplicated. The plants were grown

*The un-named variety or strain from which Selection No. 1 was obtained was discovered growing in a farm garden where roots of other pole snaps were injured by nematode. Plants and young pods of this selection have a decided purple color. The flowers are purple and mature seeds are very dark blue or black. The valves of the pods are thick. There is some variation in pods but, in general, they are almost round and tend to be stringless until the beans are well developed. The plants endure dry weather well and fruit over a long period.

Selection No. 2 was obtained from garden run of seed sent in by a farmer in a community where this un-named variety or strain was very popular due to its heavy bearing and long fruiting season. The color markings of the plant, flowers, young pods and mature seed resemble those of Selection No. 1. The valves are thin. The pods are not as plump and do not remain stringless as long as in Selection No. 1, nor does it possess the latter's high quality.

Selection No. 3 was also sent in by a farmer. Plants are purplish in appearance. The young pods tend to be green, soon changing to a typical wax; upon approaching maturity they become decidedly purple and finally almost red. The pods are plump and tend to be stringless until well developed. Mature beans are dark blue or black.



VARIATION IN NEMATODE RESISTANCE
Figure 10

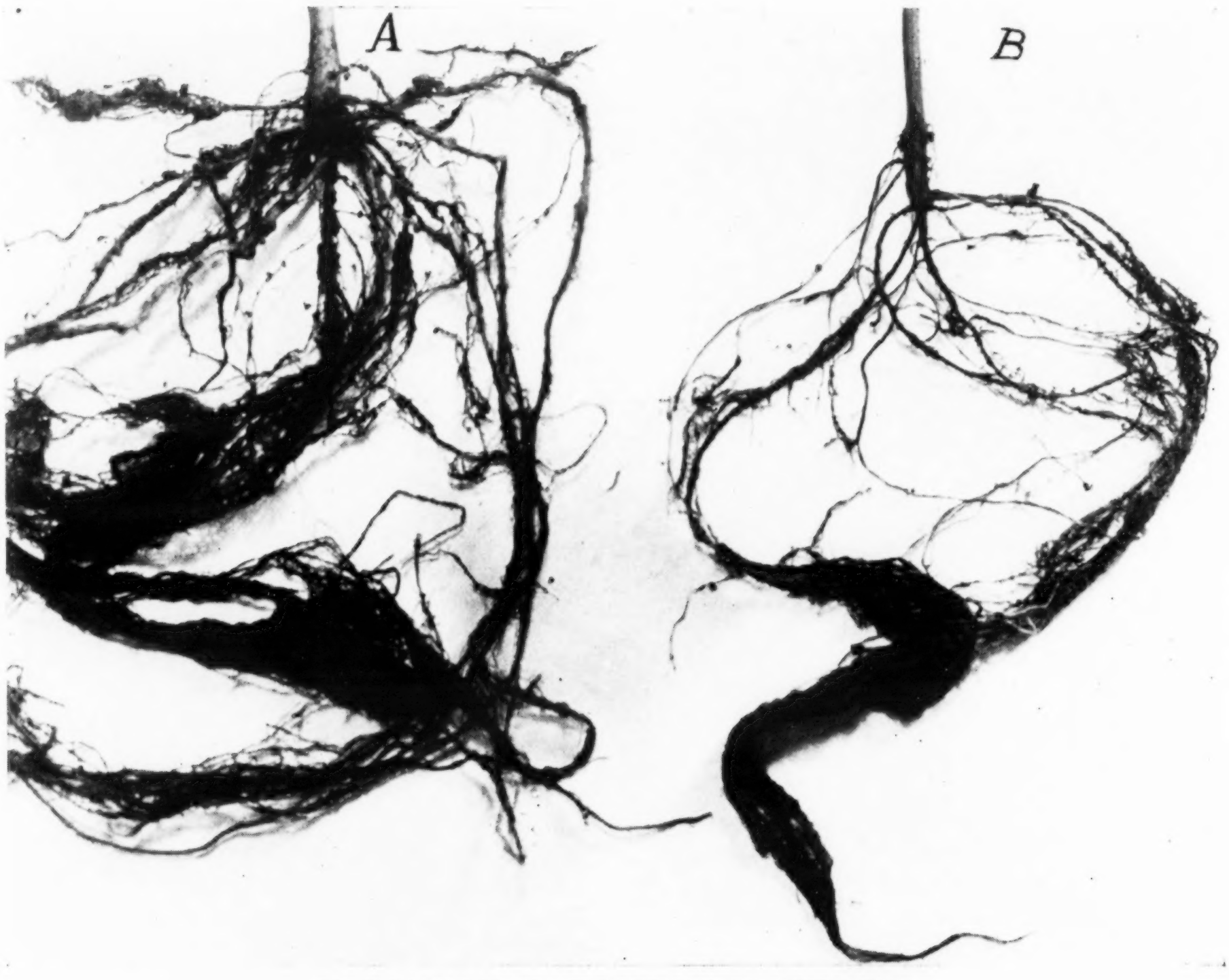
Roots of two Kentucky Wonder plants grown in the same pot; *A*, damaged considerably by nematodes; *B*, damaged very slightly (some of the nodules being those produced by nitrogen-fixing bacteria). The variation in resistance found in plants of the same variety suggests that the production of resistant strains by selection would not be difficult.

until all had some beans nearly mature. Then the plants were taken up, the roots washed and examined.

Table I gives the results obtained from this experiment. With the Kentucky Wonder there was a decided tendency for some plants to be more resistant than others. This is clearly shown in Figure 10. The plants shown in this figure were grown in the same pot.

The roots of all plants of Selections No. 1 and No. 2 in this experiment were free from nematode injury. This was true regardless of whether the Selections were grown in pots with a plant of the same selection or with an infested plant of the Kentucky Wonder. The roots of the Kentucky Wonder grown in pots with Selection No. 1 were damaged by nematode while the roots of Selection No. 1 were not (Figure 11). The enlargements on the roots of Selection No. 1 were either nodules due to bacteria or apparent enlargements due to the impossibility of bringing all of the roots into sharp focus when making the photograph. The main roots of plants of Selection No. 1 are usually longer and larger than those shown in Figure 11.

The roots of all plants of Selection



VARIATION IN DIFFERENT STRAINS

Figure 11

Roots of a plant of Kentucky Wonder (*A*) and of a plant of Selection No. 1 (*B*), grown in the same pot. The resistant strain (No. 1) originated in a plant found in a nematode-infested garden.

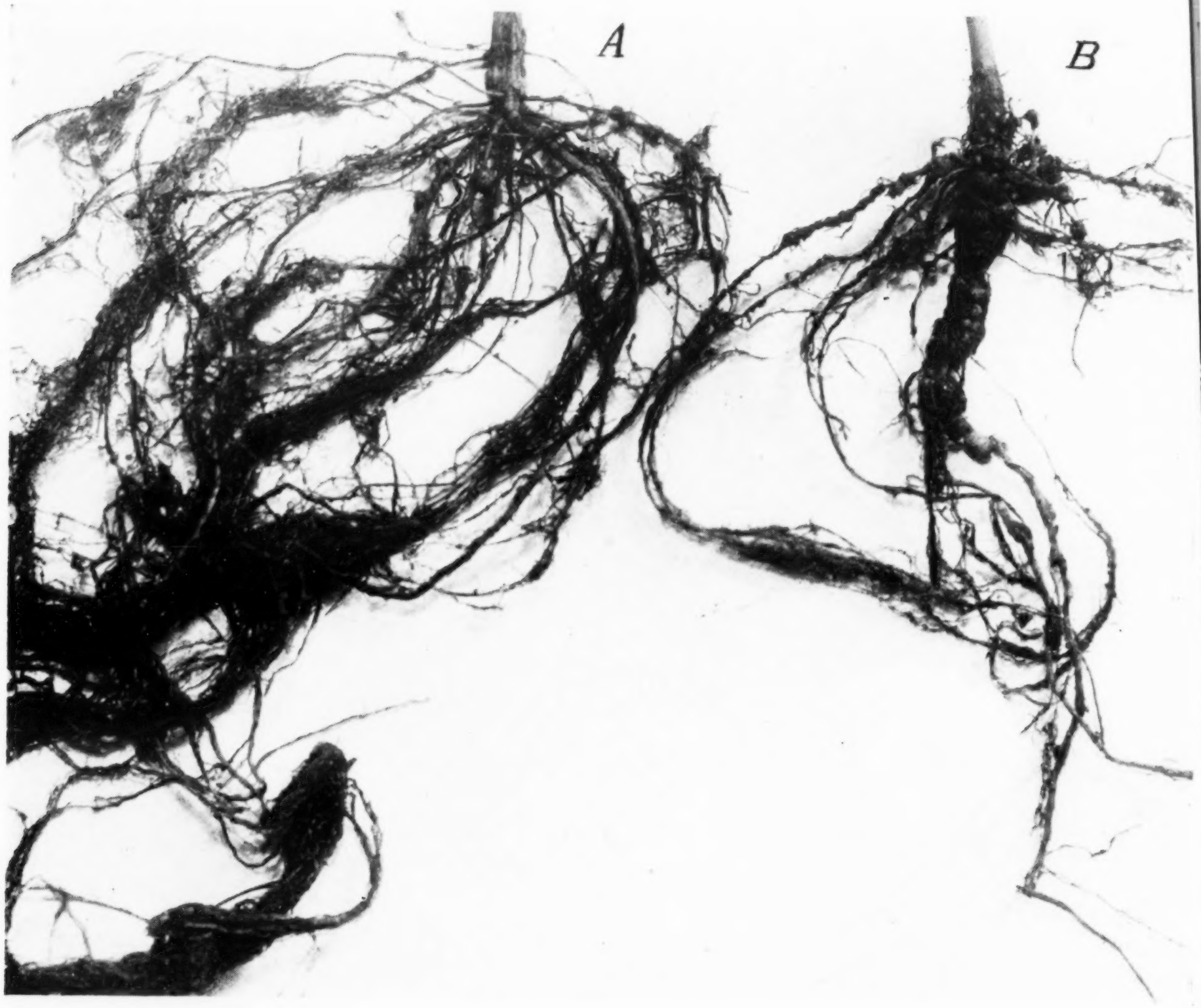
No. 3 were infested, most of them heavily. The roots of the Kentucky Wonder grown in the same pot with Selection No. 3 were damaged, but not severely, while those of Selection No. 3 were severely damaged. This is shown in Figure 12.

Experiment II. Experiment II was quite similar to experiment I except that sections of a greenhouse bed were used instead of pots. This experiment was started May 3. Seeds of Selections Nos. 1, 2, 3, and Kentucky Wonder were planted in each of three small sections of a greenhouse bed. Cabbage had previously been harvested from the bed. The roots of the cabbage plants were still alive and were infested with nematodes. These were left in the bed. The bean plants were grown until July 3 when most of them had produced some beans. At that time, the plants were taken up, the roots examined,* and photographed.

Table II gives the results obtained from this experiment. Results agree with those obtained from the pot experiment. The Kentucky Wonder varied in degree of susceptibility, but the majority of the plants were infested.

Selections No. 1 and No. 2 were free from nematode injury with the

*In this experiment and in experiments III and IV, the roots of the plants were carefully taken up with a spade, which meant that the very small roots were left in the soil. Examinations were made without the use of magnification.



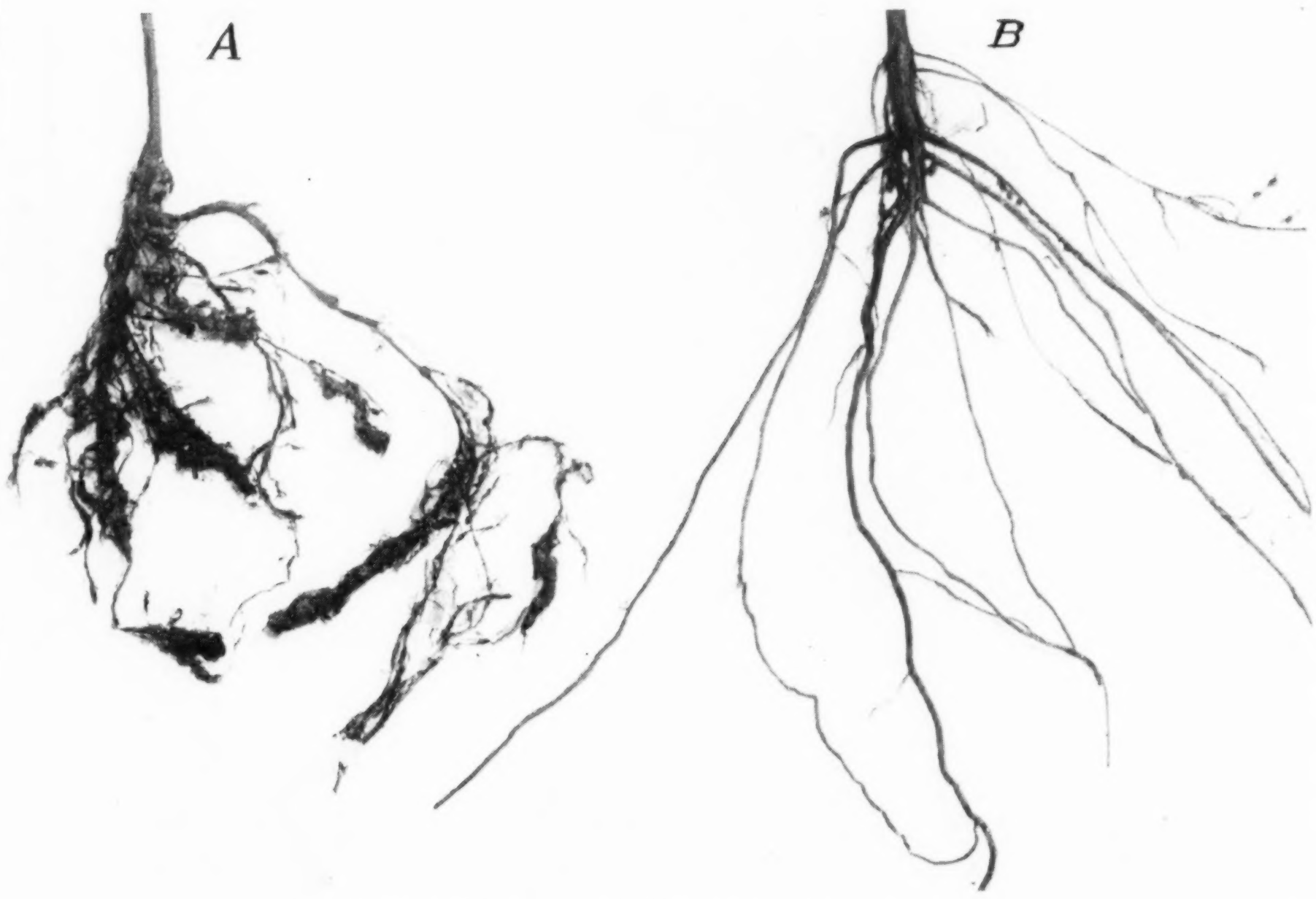
A VERY SUSCEPTIBLE STRAIN
Figure 12

Roots of Kentucky Wonder and Selection No. 3 plants grown in the same pot; *A*, Kentucky Wonder; *B*, Selection No. 3. Kentucky Wonder plants varied in degree of infestation, but practically all plants of Selection No. 3 were heavily infested.

exception of one off-type plant in Selection No. 1, and two questionable plants in Selection No. 2. The roots of the two questionable plants were slightly abnormal and appeared to be damaged, but the damage could not be definitely attributed to nematode injury.

All plants in Selection No. 3 were infested and some were killed, apparently from nematode injury. Figure 13 illustrates at *A* the roots of a plant that was killed; at *B* an un-injured plant of Selection No. 2 grown in the same bed within three feet of the former. The enlargements on the roots of *B* are nodules. The clean, smooth, well-developed, deep-penetrating root system shown in Figure 13 *B* is characteristic of the root systems of the immune selections.

Experiment III. Experiment III compared the resistance of the three different selections when grown in a field in a soil heavily infested with nematode. This experiment was started April 15. Two rows of Selection No. 1, one row of Selection No. 3, two rows each of Selection No. 2 and a purple pole lima bean were grown in the order named. Hills at intervals along the rows of the pole snaps were taken up June 30 to July 2. The others were grown until



SUSCEPTIBLE AND RESISTANT STRAINS

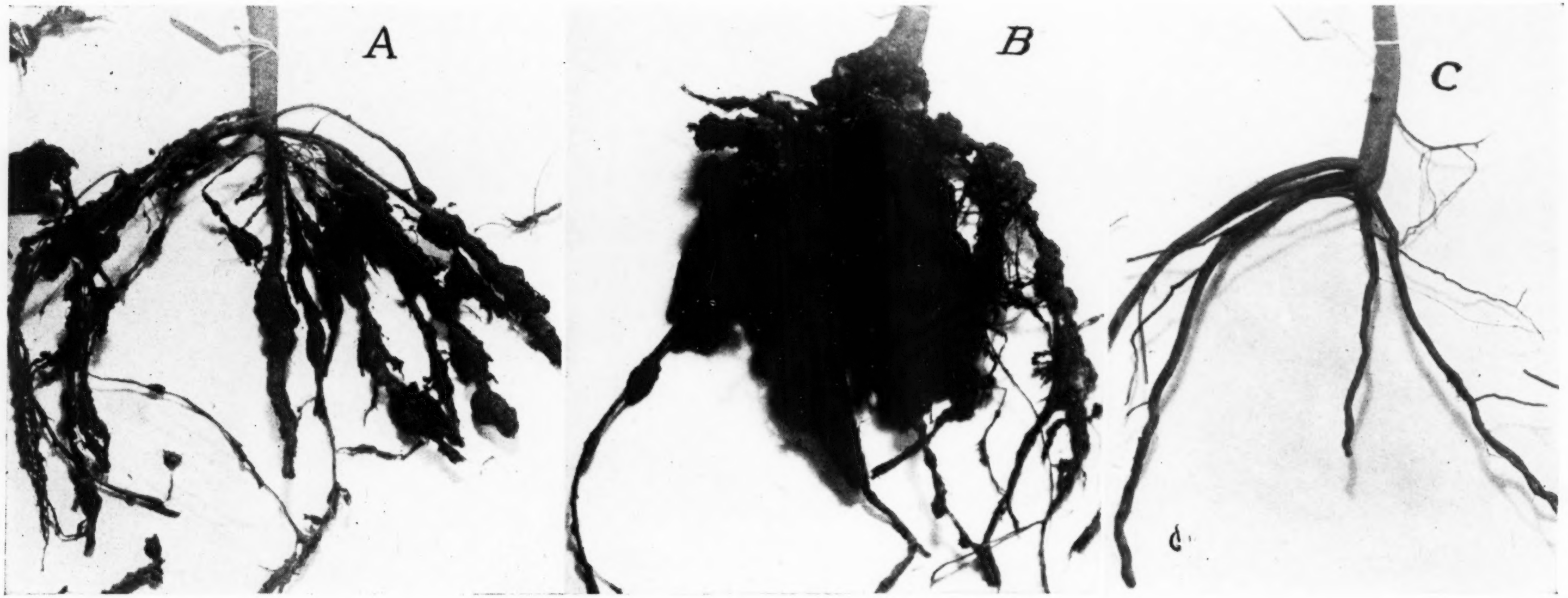
Figure 13

Roots of Selection No. 2 and No. 3 plants grown in the same bed; *A*, Selection No. 3; *B*, Selction No. 2. The resistant strains are comparable to the standard varieties in yield and in culinary qualities.

August 2 to determine whether the percentage of infestation would increase.

The percentage of infestation did not increase with the plants left unharvested until August 2 and only the totals for the two examinations are reported. Table III gives the results obtained. The results of this experiment were much the same as those in the greenhouse in both pots and beds. The plants reported off-type in Table III were either off-type in bloom, foliage, or more than one of these. No photographs were taken to illustrate relative infestation when the plants of Selection Nos. 1, 2, and 3 were taken up, but Figure 14 *A* shows the degree of infestation of a typical pole lima bean plant grown adjacent to Selection No. 2.

Experiment IV. Experiment IV was conducted to test the nematode resistance of Selection No. 1 when grown and fruited under garden conditions in an infested soil and to obtain information on the eating quality. Two rows of Selection No. 1, comprising 123 plants, were grown from a planting made April 20 in a garden where roots of okra, tomatoes, and other vegetables were heavily infested in 1929 and 1930. Two rows of pole limas were grown adjacent to Selection No. 1 as a check on the extent of infestation. A few plants of Selection No. 1 were dug up at different intervals during the fruiting season and the roots examined for nematode injury. During the fruiting season, which lasted until about September 20, observations were made on productiveness. Beans were harvested as string beans and these were used by several parties to test eating quality. The remainder of the plants of Selection No. 1 were taken up September



FIELD INFESTATIONS WITH NEMATODES

Figure 14

A, Roots of pole lima showing typical infestation of plants grown in a field heavily infested with nematode; *B*, roots of pole lima; *C*, roots of Selection No. 1 pole snap plants grown in garden soil within three feet of the infested plants.

27 and the roots examined. Plants of the limas were taken up October 31.

Table IV and Figure 14, *B* and *C*, give the results obtained from the experiment. Of the two plants of Selection No. 1 that were not definitely diagnosed as free from nematode injury, one was off-type and the injury to the roots of the other was very slight and could not be definitely attributed to nematode injury. Again this selection proved practically if not entirely immune. Figure 14 illustrates at *B* and *C* respectively, roots of the pole lima and Selection No. 1 that grew in adjacent rows not more than three feet apart. They were planted on the same date and taken up on the same date.

Although there were no laboratory tests made to determine quality, people who were familiar with standard varieties were supplied with beans of Selection No. 1 with the request that they give an opinion as to its eating quality. Reports were to the effect that its quality compared favorably with standard varieties, such as the Kentucky Wonder and McCaslan.

Experiment V. Experiment V compared the yield of Selection No. 1 with the yield of different standard varieties grown under conditions where nematode injury was not a limiting factor. A triplicate planting of five varieties of pole snaps with Selection No. 1 as a check was made May 30, 1930. Harvests were made as green beans until the plants ceased bearing, which was about the middle of September. Table V gives the results of this experiment. Data in table V show that Selection No. 1 compares favorably in yield with the standard varieties of pole snap beans.

TABLE I.—Relative Resistance to Nematode of Kentucky Wonder and Selections of Pole Snap Beans Grown in Heavily-Infested Soil in Pots in the Greenhouse.

Variety	*No. pots*	*No. of plants*	*Degree infestation*
Kentucky Wonder	12	15	Some plants free or very slightly; infested others very heavily infested
Selection No. 1	6	9	All free
Selection No. 2	6	9	All free
Selection No. 3	6	9	All plants infested; most of them heavily infested

TABLE II.—Relative Resistance to Nematode of Kentucky Wonder and Selections of Pole Snap Beans Grown in Heavily-Infested Soil in Beds in the Greenhouse.

Variety	*No.of plants*	*Degree of Infestation*	
		Free	*Infested*
Kentucky Wonder	46	13	33
Selection No. 1	43	42	1*
Selection No. 2	36	34	2†
Selection No. 3	18	00	18‡

*Plant off type

†A few roots slightly abnormal, but cause not definitely determined.

‡Two plants killed, apparently from nematode injury.

Summary

1. During the growing seasons of 1928 to 1930, inclusive, a study was made under field and greenhouse conditions to determine whether nematode-immune varieties or strains of pole snap beans existed and, if so, to isolate such immune varieties or strains that produced satisfactory yields of beans of good quality.

2. Varieties of pole snap beans differ widely in their resistance to nematode.

3. Two selections from un-named varieties were highly resistant if not entirely immune to nematodes under conditions where standard varieties of pole snaps and pole lima beans were heavily infested.

4. Both of the resistant or immune selections were heavy yielders.

5. One of the resistant or immune selections compared favorably in quality as a snap bean with the best standard pole snaps, such as the Kentucky Wonder and McCaslan.

Literature Cited

1. Cowpeas, Culture and Varieties. 1924. *Farmer's Bul. No.* 1148, U. S. Dept. Agric., Washington.

2. Root Knot, It's Cause and Control. 1923. *Farmer's Bul.* No. 1345, U. S. Dept. Agrig., Washington.

3. Control of Root Knot by Velvet Beans Under Constant Cultivation. 1923. *Fla. Agr. Sta. An. Rept.*, June 30, page 108.

TABLE III.—Relative Resistance to Nematode of Three Selections of Pole Snap Beans Grown in Heavily-Infested Soil in the Field.

	Number of Plants		*Degree of Infestation*		
Selection	*Examined*	*Off type*	*Free*	*Some*	*Heavy*
No. 1	47	5	41	6*	0
No. 2	37	4	34	2	1
No. 3	20	3	2	2	16

TABLE IV.—Resistance of Selection No. 1 Pole Snap Bean to Nematode under Garden Conditions in Heavily-Infested Soil.

	Selection No. 1	*Pole lima used as check*
No. plants grown	123	110
No. plants free	121	64
No. plants heavily-infested	0	40

TABLE V.—Comparative Yield of Green Beans In Pounds Per Acre of Standard Varieties of Pole Snaps and Selection No. 1 Grown in Soil Where Nematode Injury was not a Limiting Factor.

Variety	*No. of plants grown*	*Yield per acre of green beans*
Kentucky Wonder	60	7,887
Cornfield	65	9,389
McCaslan	57	6,966
Southern Prolific	65	6,179
Ideal Market	68	9,408
Selection No. 1	80	8,016

*A few of the roots of one of these plants were apparently damaged, but the damage could not be definitely diagnosed as nematode injury.

Race Differences In Disease

FIVE groups of population characterized by a dominance of a particular race were studied within the borough of Manhattan from the point of view of demographic characteristics, environmental factors, and the incidence, death rate and case mortality among children under 5 years of age in these groups, from measles, diphtheria and scarlet fever. These groups, subjected as they are to the same climatic conditions and as nearly uniform opportunities for contact exposure within and without the home as are likely to be found in any urban population, show no correlation between the variations in the incidence and death rates from these diseases, and such factors as density of population per acre, number of persons per family, or proportion of children under 5 to the total population group. Significant differences are found in the death and case incidence rates and in the case mortality percentages for measles, diphtheria and scarlet fever but do not appear to be explained by other factors than those of racial susceptibility and resistance. So fas as the statistical method can be used to offer evidence on this point, it seems that the factor of race is the only one of importance that can be recognized clearly as a variant of significance among the population groups studied. The five groups were the children of native born white people of native parents, of Negroes, of Italians, of Russian-Polish, and of Irish.

DISCUSSION

DR. EUGENE L. OPIE, Philadelphia: On the basis of case incidence in relation to death, there are some observations which show striking differences in case incidence. Cummings, during the war, found among 10,000 Negroes from Africa that there were just as many deaths as in the entire British army. There were two cases for every death, while among the white men there were seventeen cases for every death.

HAVEN EMERSON, in *Journal of American Medical Association*, June 20, 1931.